OHIO BRASS MANAGEMENT REPORT

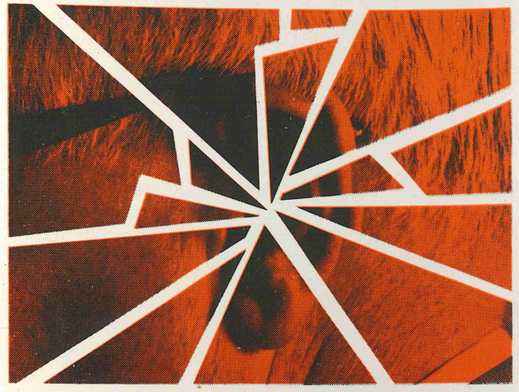
Listen for the voice of the rebel, even when it hurts

BY ROGER A. BLACK
PRESIDENT, OHIO BRASS COMPANY

Look at any successful organization and you can see it has a fair share of rebels who have contributed significantly to the organization's progress. We need rebels... the constructive ones. I would wager that one whispered encouragement to Christopher Columbus as he stood before Queen Isabella and King Ferdinand:

"SO THE KING'S COMPUTERS say the world is flat. But you and I know it's round. Let's get this project started." One probably stood with the minutemen (rebels all) at Lexington: "Sure we're outnumbered. But we want a free country. Let's chase those Redcoats back to England." Getting effective help from the rebel requires special understanding and techniques. Among them is the ability to distinguish the constructive rebel from the one who rebels just to hide his own inadequacy. It also calls for ability to accept criticism. In any suggestion there is implied complaint against the status quo.

DO YOU KNOW what your employees really think about the Company and its management? We say we do. At least we believe we know what the respon-



sible employees think. But when you listen to the constructive rebel, you run the risk of being shocked. Are you willing to hear him, without prejudice, even when his words sound unjust?

LISTENING ALSO CARRIES THE OBLIGATION to give prompt judgment on the rebel's suggestions. Too often we temporize on a decision or don't tell him what we really think, especially if we can't leap at his idea. The fact he makes the suggestion indicates he should be able to accept either a positive or negative reaction. Give him credit for this much maturity and tell him what you really think of his ideas.

THESE SUGGESTIONS have been offered in the belief that appreciation and understanding of rebels can be a profitable but often neglected management technique. You can probably improve on the suggestions. Now, if you'll excuse me, there are a few rebels waiting to talk to me.

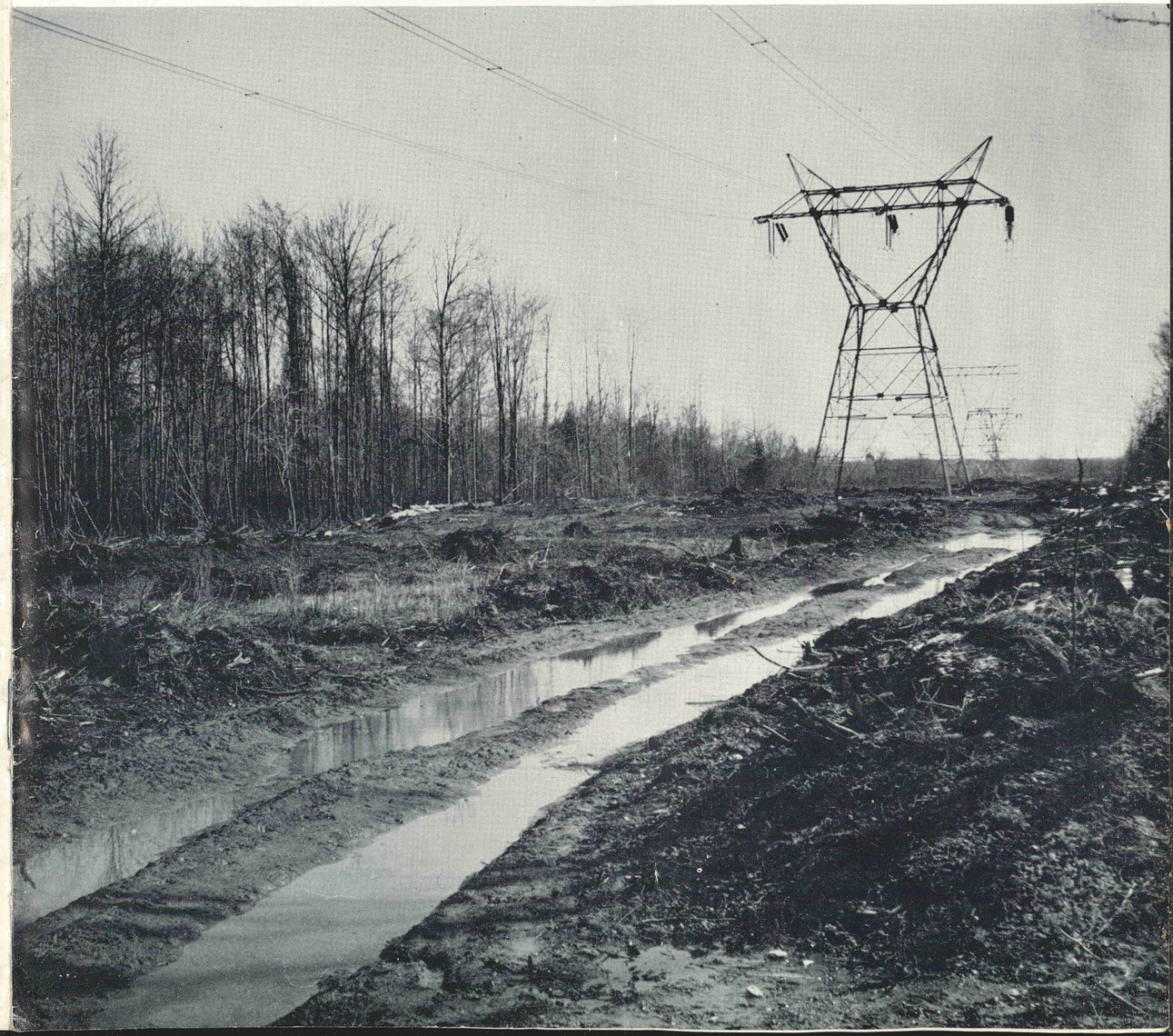
750-H

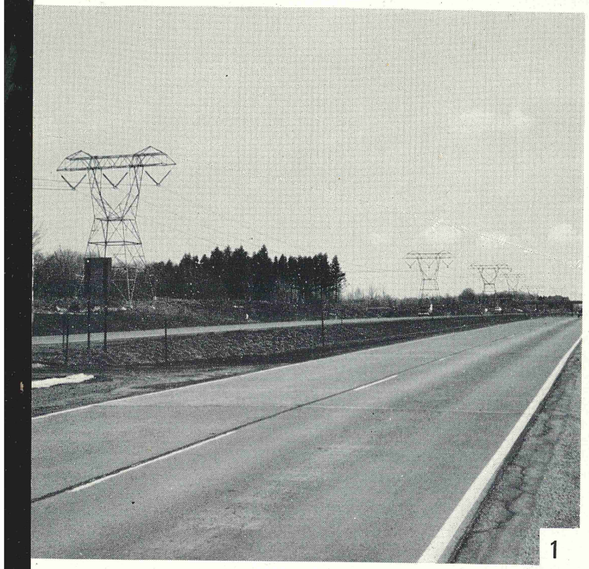
OHIO BRASS COMPANY • MANSFIELD, OHIO
Canadian Ohio Brass Co. Ltd. • Niagara Falls, Ontario

OHIO BRASS

6667-H

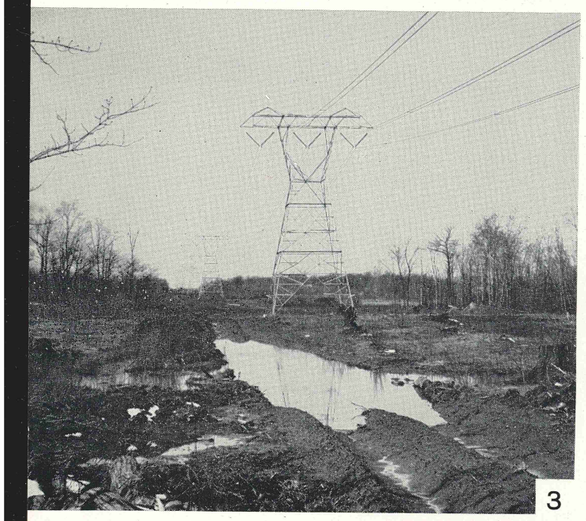
OB Hi-Tension News
JULY 1966



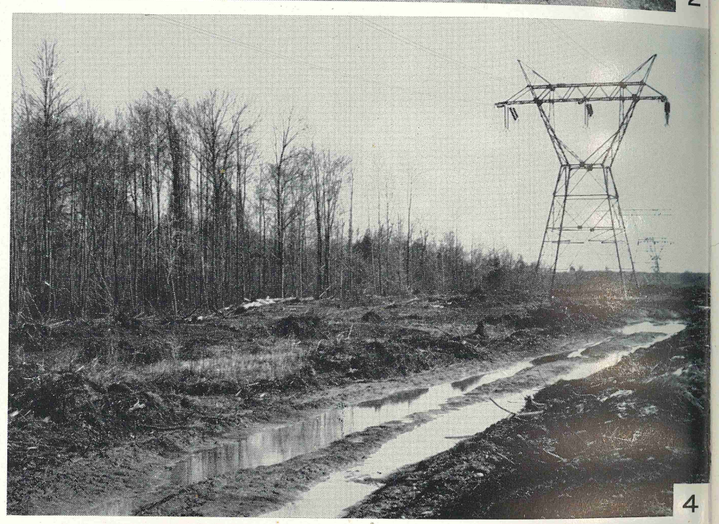


1

2



3



4

1, 2 For a portion of its length, the new Penelec tie parallels Interstate 90 west of Erie, Pa. Some of its length traverses a thickly built-up rural district and, near the city, runs adjacent to valuable real estate. Restriction on right-of-way at various points calls for a minimum width which is as narrow as 100 feet. This is accomplished by close structure spacing which reduces the clearance required for horizontal wind blow-out of conductors, materially aided by full V-string construction. Parts of the line are within sight of the shore of Lake Erie, in the absolute heart of the Great Lakes "snow belt." Icing, wind, and a generally severe environment call for a heavily built system.

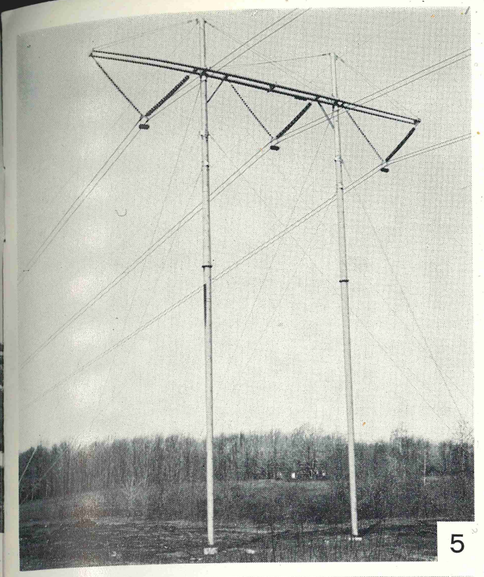
3, 4 Soil conditions over parts of the line are not favorable for the support of heavy transmission structures. Land is poorly drained and often swampy, as these early spring photos attest. Approximately 50 per cent of the towers stand on four concrete-filled caissons, nine feet in diameter and 10 to 14½ feet deep.

5, 6, 7 At the western end of the line, near the Ohio border, steel Monotube H-frame structures have been employed. These were moved from the Penelec 460-kv experimental line after it was dismantled when tests were completed. At points in this section, as one of the pictures shows, new self-supporting towers have been inserted where greater conductor height is called for.

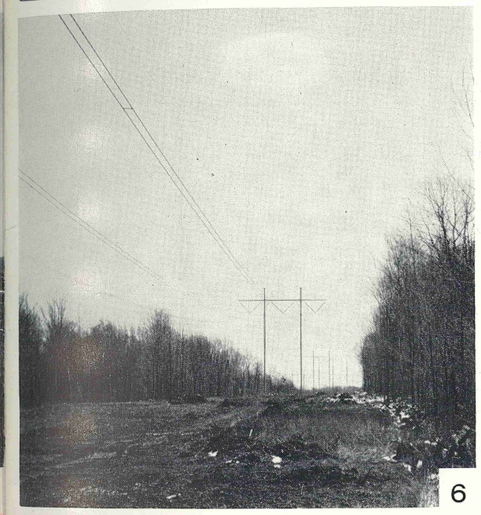
Hi-Tension News
July 1966, Vol. 35, No. 7

ON THE COVER - While quite short in length, Penelec's new tie with Cleveland Electric Illuminating Co. is a study in contrasts. This less photogenic section is typical of 50 per cent of the line where soil conditions call for concrete footers 9 by 10 to 14½ feet.

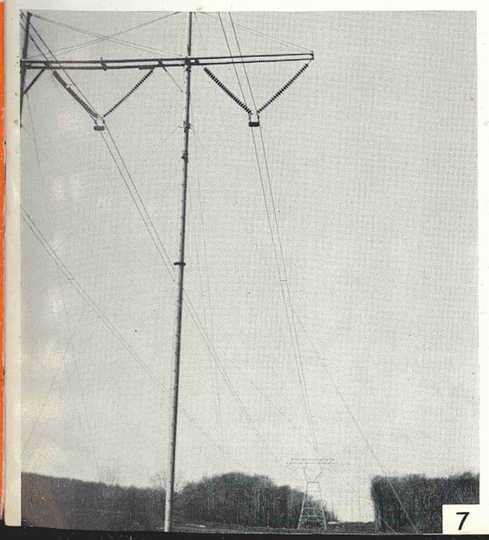
OHIO BRASS CO., MANSFIELD, OHIO



5



6



7

Penelec completes important EHV inter-tie

Connects two major utilities and will ultimately feed into Keystone network

While less than 50 miles long, the newest EHV line of Pennsylvania Electric Company is, and will probably remain, one of the more important sections of the company's system. Constituted for 345 kv and initially operating at 230 kv, this line is the first interconnection with Cleveland Electric Illuminating Company, and is the first step in planned transmission growth. Besides providing reinforcement to local areas of both companies, and for interchange of power, this line will serve as the C.E.I. tie to the jointly owned Seneca Pumped Storage Project near Kinzua. Later, as the Penelec EHV network progresses, a substation will be built near the state line, connecting this interchange directly into the huge Keystone, Homer City, and Conemaugh Projects.

The new line terminates at the Erie-South substation, located at the southern edge of Erie, Pennsylvania. A portion of the line runs parallel and closely adjacent to Interstate 90. This route follows the southern shore of Lake Erie, through the heart of the infamous "snow belt." Consequently, the line must be built for heavy winter loadings, mainly ice and wind. This is evident

(Continued on next page)

(Continued from previous page)

in its construction. Twin conductors of 1,033,500 cir mil are supported on heavily built towers.

An interesting sidelight of this line is its utilization of some previously installed materials. A few years ago, Penelec built a prototype 460-kv experimental line, from which a great deal of EHV construction and operating data was derived. This line consisted of a variety of structure designs and other mechanical details. After it had served its purpose, it was dismantled and some of the material for the present line was recovered. Included were several miles of steel Monotube H-frame towers, part of the insulation, and many other items of line equipment. The insulation, yokes, conductor clamps, and most of the accessory hardware on this line are of O-B manufacture. Recovery of part of the material helped reduce cost, and provided a welcome relief in view of special construction demands.

For approximately 50 per cent of the line's length, soil conditions offer inadequate support for towers and, at each structure, four caissons nine feet in diameter and 10 to 14½ feet deep, filled with concrete, were required to support the tower legs. Large swamp areas are common throughout the district, and it was impractical to extend the line sufficiently to avoid them. Hence, the majority of towers literally "float" on concrete.

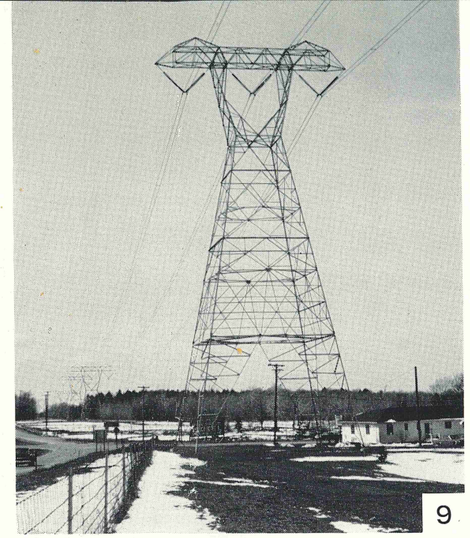
In so short a distance it is unusual to see such a variety of right-of-way, from almost waste land to areas of costly real estate which are sites of luxury motels bordering the southern edge of the city of Erie. Only a few miles apart one can find a section inhabited largely by mud turtles and water snakes, and then a little down the line, a tower standing practically in the parking lot of a deluxe hostelry.

This variation in right-of-way has had a considerable influence on construction. Where land values are relatively low, long spans and higher towers may be utilized. This permits greater horizontal wind blowout of conductors and, accordingly, wider side clearances. Conversely, where land is much more restricted, spans are shortened and towers are consequently lower, to bring right-of-way down to a width of only 100 feet. Highway crossings and special clearance requirements also influence tower dimensions. The standard ruling construction is a tower on 1,300-foot spacing, with the conductor support 66 feet above ground. This tower may be equipped with body extensions of 10 or 20 feet, and leg extensions that can run to 30 feet. One of the towers at a highway interchange measures 116 feet to the conductor. Steel Monotube H-frame construction exists where the ruling 66-foot clearance is permissible.

Penelec has lines many times as long, often through mountains, that presented fewer problems of construction than this small section running from the Ohio-Pennsylvania border to the city of Erie.

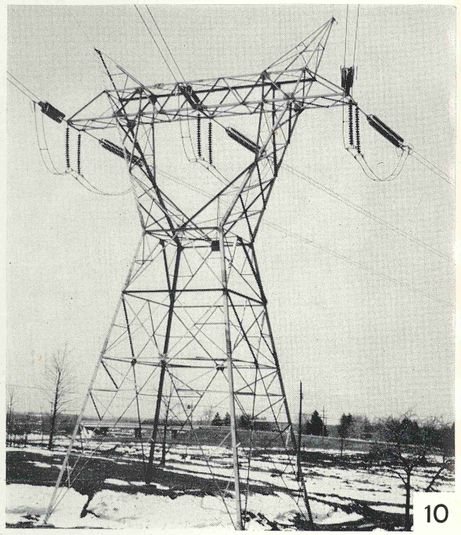
8, 9 Because of the need for exceptionally high clearance at a freeway interchange, extensions were added to one of the towers to raise the conductors 116 feet at their point of support.

8

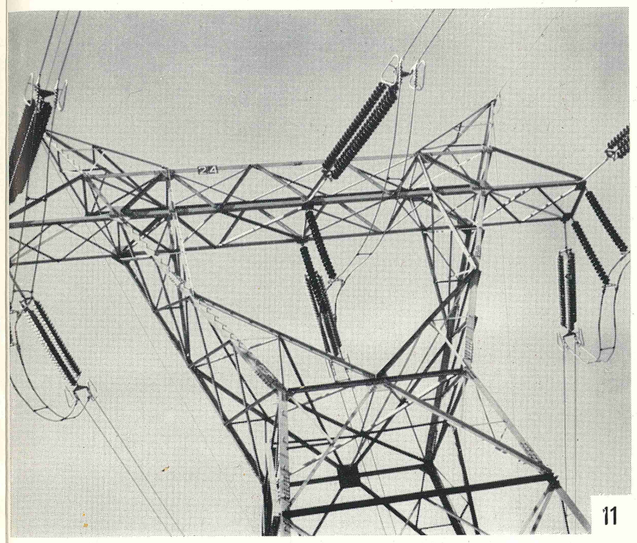


9

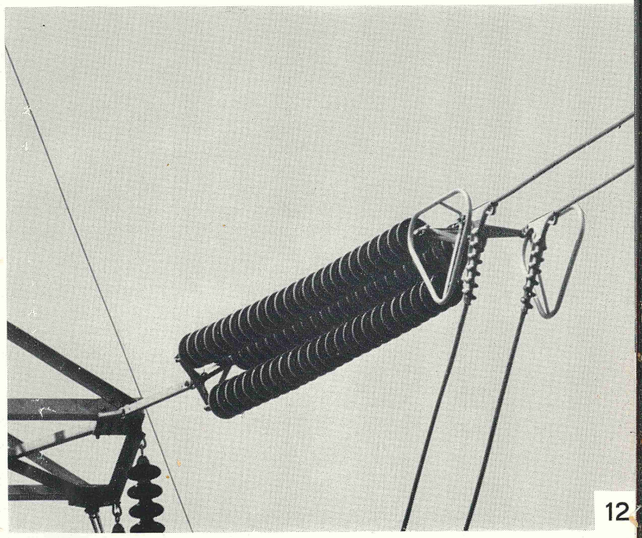
10, 11, 12 Some of the construction materials on this heavy angle tower, and throughout the line, were recovered when Penelec dismantled its 460-kv experimental project. Insulators, yokes, suspension clamps, and bolted segmental strain clamps are of O-B manufacture.



10

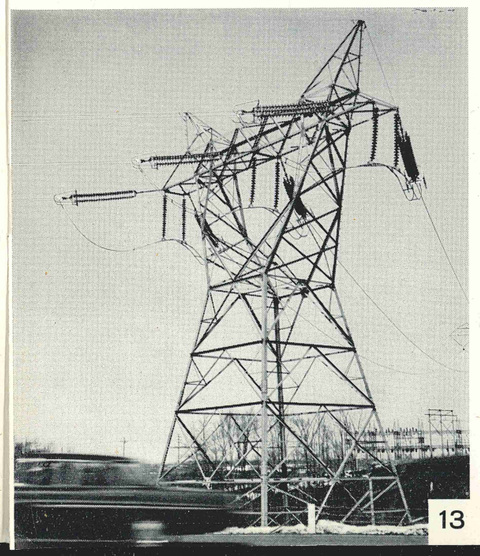


11



12

13 In the background is Erie - South substation, terminus of the line, adjacent to the junction of Interstate 90 and Route 97. This major inter-tie connects two large utilities, permitting an exchange of 400 MVA at 345 kv.



13

Industry's most durable intermediate arresters also have industry's safest pressure-relief devices

The exclusive current-limiting Dynagap construction of all Ohio Brass GP intermediate arresters provides operating advantages so pronounced that other important features of the arresters are occasionally overlooked or unrecognized. Because intermediate arresters usually represent specific efforts to install the best protection for the money invested, point-by-point investigation of comparative qualifications can lead to handsome dividends in performance.

Any comprehensive evaluation of arrester design should include consideration of precautionary measures taken in event of arrester faults, since abnormal system occurrences can and do establish conditions under which no arrester is able to survive. When today's high-capacity systems are short circuited, the release of energy inside a faulted arrester in the form of material decomposition and vaporization is enormous. Internal arrester pressures of several thousand pounds per square inch can be reached within a few thousandths of a second. The result, depending on the existing provisions for pressure relief in the arrester design, can be a violent porcelain explosion, a delayed-action bomb, or a harmless, automatically vented-arrester housing.

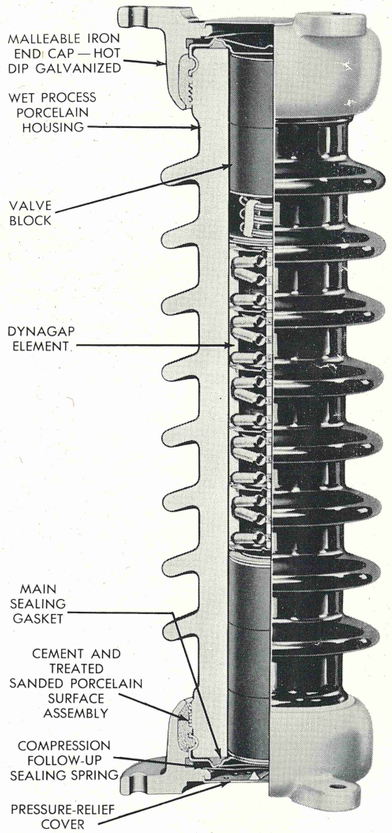


Figure 1 — GP Dynagap intermediate arresters have pressure-sensitive relief system which operates directly as a result of abnormal increases in gas pressure within the sealed arrester.

The pressure-relief facilities incorporated into the O-B Dynagap intermediate arresters function on the same principle as those furnished on Ohio Brass' most expensive and advanced station-class arresters. Safer operation of O-B's relief system is assured because venting provisions are actuated by *pressure-sensitive* components, thereby completely eliminating the difficulties associated with other methods used to initiate relief action.

Abnormal pressure resulting from gas buildup within a faulted GP arrester is reduced to a safe level through a two-stage venting operation with so swift a response speed that both stages can occur simultaneously if conditions warrant. Purpose of the two-stage vent is to provide the broad sensitivity to excessive pressure that will effectively prevent slow as well as fast buildups of an explosive potential. Pressure within GP intermediate arresters cannot, therefore, reach proportions which make physical handling dangerous.

Low-fault-current operation of the GP relief system occurs when a pressure increase within the arrester causes the pressure-relief diaphragm (Figure 2) to reverse its normal concave upward position and flex downward. This cupping

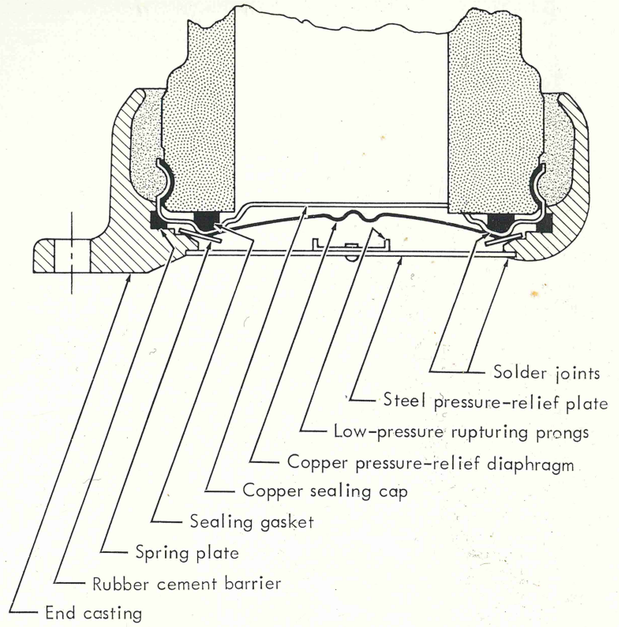


Figure 2 — Section drawing of base of GP intermediate arrester, illustrating arrangement of pressure-relief components. Note that position of relief diaphragm is concave upward at normal pressure.

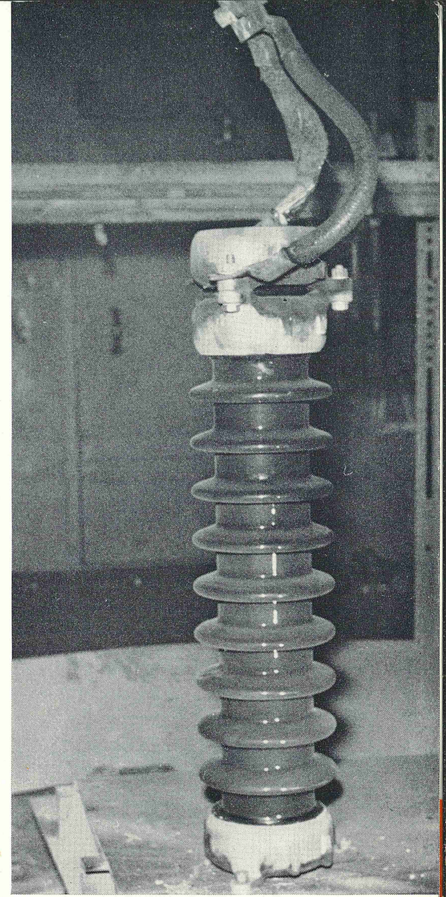


Figure 3 — Photograph of GP-37 intermediate arrester made immediately following the successful completion of pressure-relief test conducted at high-power-testing laboratory in Ludvika, Sweden.

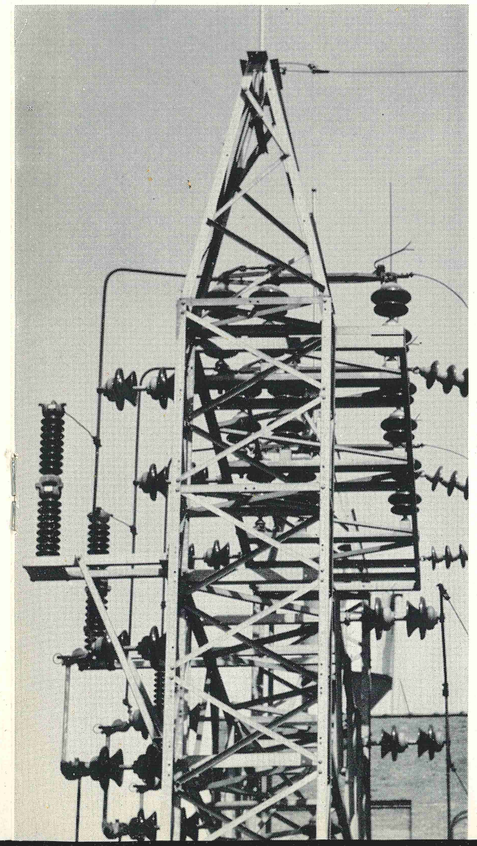


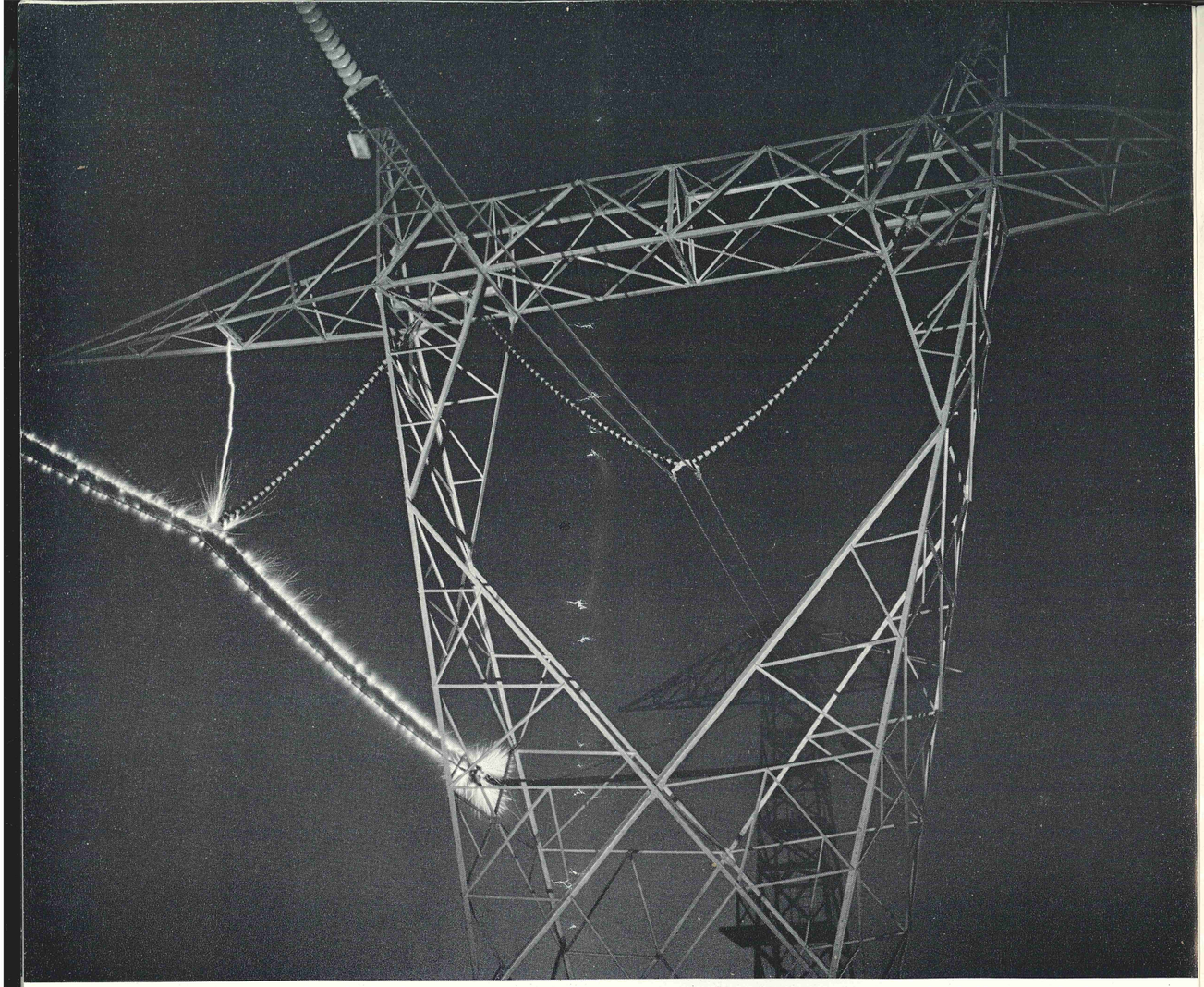
Figure 4 — Typical installation of GP Dynagap lightning arresters at 69-kv industrial substation.

action takes place with ample force to cause twin punctures in the soft metal of the diaphragm when it engages the rigid rupturing prongs. These punctures break the completely sealed status of the arrester and permit the escape of the confined gas.

High-fault-current stage of the relief system occurs instantaneously if the punctures in the diaphragm are incapable of releasing sufficient gas to halt the increase in the internal pressure. Under such conditions the entire end seals at both ends of the arrester separate from the end castings and provide exhaust openings at least equal to the arrester cavity.

Full-scale, fault-current tests on production-model GP arresters have demonstrated their ability to provide pressure relief at currents in excess of the industry standard of 25,000 amperes asymmetrical. Figure 3 illustrates a GP Dynagap arrester immediately following the laboratory application of the huge short-circuit current required to initiate operation of its pressure-sensitive relief action.

Application possibilities for GP Dynagap intermediate arresters are expanding as utility protective engineers become more aware of their superior characteristics. Arrester dollars can be stretched to provide more and better protection for high-voltage distribution, overhead/underground terminations, industrial and feeder substations, and for many other important applications.



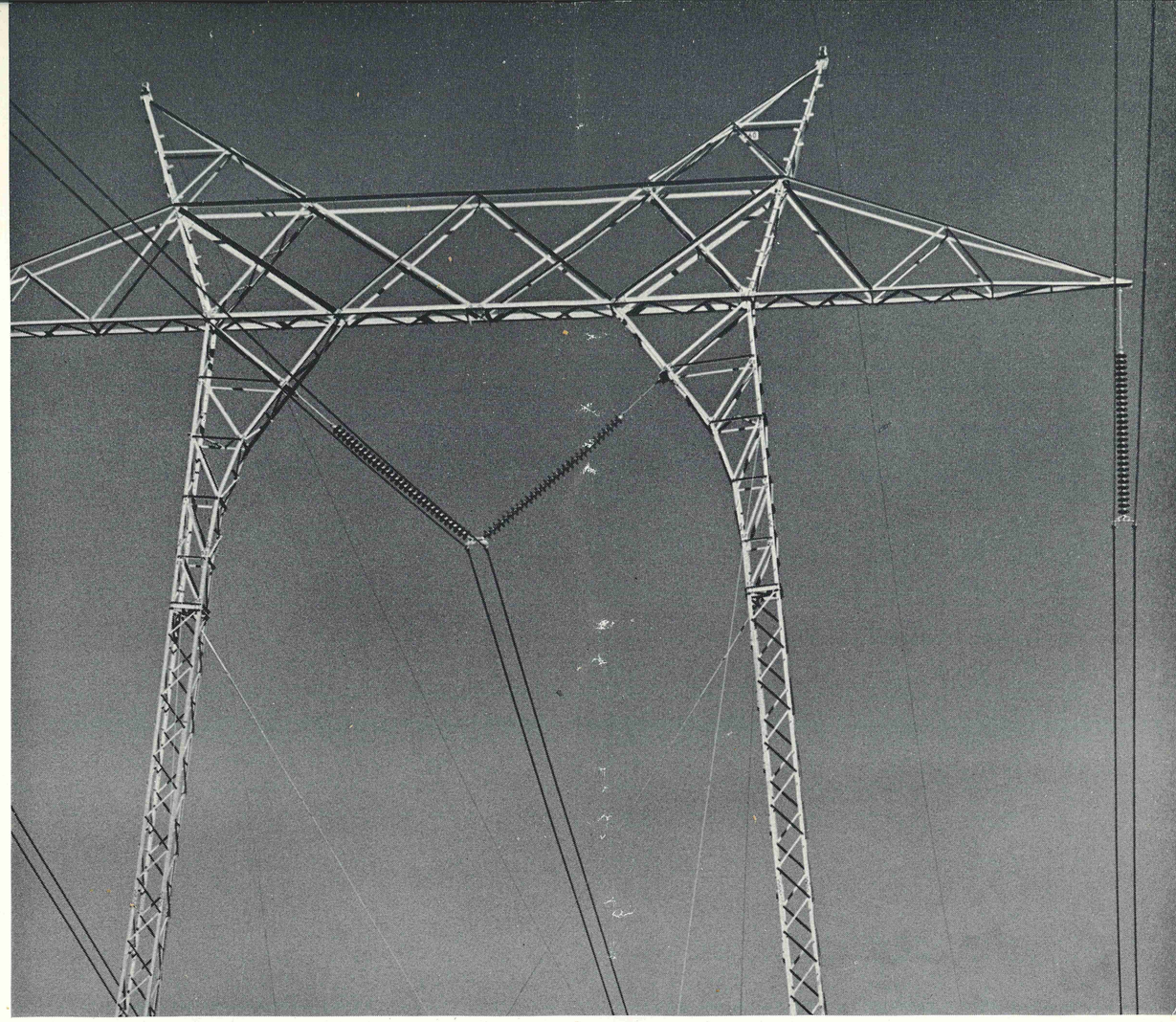
Thorough 60-cycle, impulse, and switching surge testing probed the performance capability of each of O-B's new standardized insulator-hardware systems before final design approval.

Support your new EHV line on 13,000 miles of EHV experience

O-B now offers standardized EHV insulator-hardware designs with hundreds of circuit-mile-years of successful application

Here's a practical solution to the problem of EHV insulator-hardware design. Take advantage of 13,000 miles of EHV experience and select a performance-proved O-B insulator - hardware "system" to support your new EHV line.

Application on major 345-, 500-, and 735-kv transmission lines in the U. S. and Canada has demonstrated the performance reliability of O-B insulator-hardware combinations. Several of the basic designs have been included in O-B's newest EHV extra — a complete line of "standardized" EHV transmission hardware.



Over 13,000 miles of EHV experience on transmission lines in the U. S. and Canada proved the in-service reliability of many O-B EHV insulator-hardware designs.

Whether your new line has a two- or three-conductor bundle supported by single or double strings of insulators in a vertical or V-string configuration, one of O-B's standard designs will fit. You'll save design time in the planning stages of your line and be assured of reliable performance when the insulator-hardware system is installed.

What components go into O-B's standardized EHV insulator-hardware designs? The same stabilized yokes, controlled-radius clamps, flexible "Y" fittings, and reliable O-B suspension insulators that introduced modern EHV insulator hardware. And, each insulator-hardware suspension system incorporates O-B's close-coupled design principles to reduce the necessity for control rings — the conductor bundle is used to shield the lower-end insulators and hardware.

At the heart of each O-B insulator-hardware system is the stabilized yoke. All attachment points for connecting insulators and clamps are located in-line with the yoke's rotational axis. When a transient line disturbance causes mechanical displacement of the assembly, the yoke will not bind or lock up in a static position. As a result, the suspension system remains mechanically stable and returns to normal positioning without introduction of a counter-force.

O-B's controlled-radius suspension clamps cradle your conductor on a smooth-surfaced area. Generous take-off angles and blended clamp edges allow limited conductor movement to prevent damage. Each clamp body and keeperpiece is combined to fit your specific conductor size and loading require-

(Continued on next page)

(Continued from previous page)

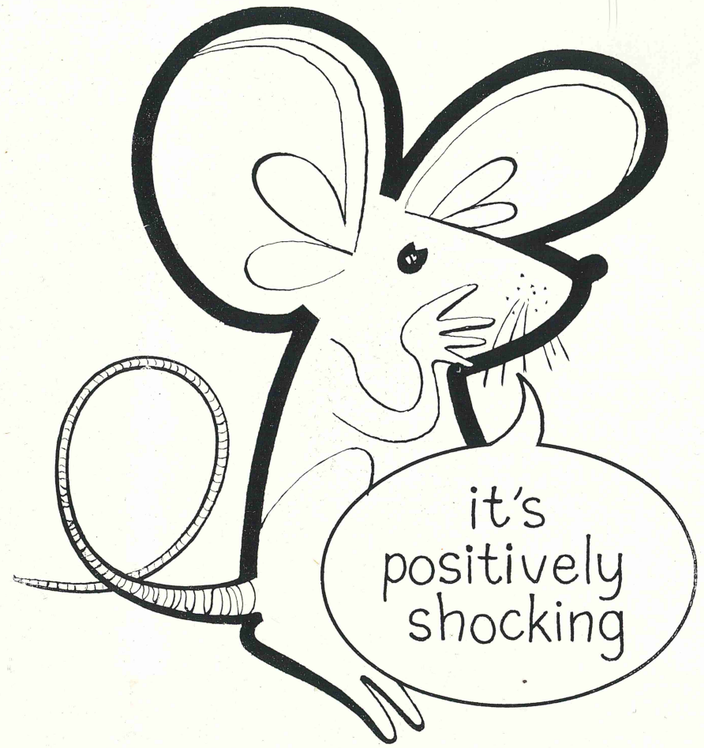
ments to assure optimum fit and performance. Casting aluminum clamps in steel, permanent molds assures consistent reproduction of the clamp's controlled-radius design and rounded edges and corners.

To connect the conductor clamps and insulator strings to the yoke, O-B includes a flexible "Y" fitting. The curved attachment bolt permits wrist-like movement of the fitting to cushion the initial blow of a mechanical transient and allows limited freedom for movement to protect insulator - hardware components from binding against each other.

O-B suspension insulators trace their heritage back to the first EHV line — the 115-kv circuit from Toronto to Niagara Falls built in 1909. Here is where the ball-socket suspension insulator was born. Today, you select from a variety of refined designs in either clevis or ball-socket types ranging in M & E strength from 10,000 to 50,000 pounds. All O-B insulators are compatible with O-B hardware because design and manufacture of both materials are controlled by Ohio Brass Company.

In addition to the practical experience of hundreds of circuit-mile-years of successful application, each of O-B's standardized EHV insulator-hardware systems shares a common background of thorough proof testing in the O-B High Voltage Laboratory. In the laboratory's all-weather outdoor area, complete 60-cycle, impulse, and switching surge tests proved each design's performance capability for EHV before construction. Combine this development background with the on-line experience of each design, and you have the best assurance of reliable EHV performance in the industry.

If you're in the planning stages of a new EHV line, let O-B help solve one of your many problems. Ask your O-B district manager to show you the complete line of O-B standardized EHV insulator-hardware systems available to support your new line.



O-B conduction paint performs "beyond the call of duty"

In a recent issue of Hi-Tension News there appeared an item on the use of O-B Conduction Paint to reduce RIV on untreated distribution insulators.

Without detracting from these more serious applications, we can't resist reporting on another important use of this product.

It seems that a service center was in a very old building, adjoined by some less-than-sanitary lunch stands. This building was infested with the largest, healthiest rats in town. They were even getting sassy with the linemen, and had started declaring squatter's rights.

So, along the rat runs the men first stretched pieces of masking tape. Then they painted the runs with conduction paint. After lifting the tape, they connected the two separate strips of conduction paint to a small transformer, locked the building and went home.

Understand, now, this isn't our story . . . it was told us by the foreman. He related that the following morning they cleaned dead rats out of the place with shovels. After a few days all the rats were gone, and stayed gone. Maybe they didn't understand electricity, but they got the message.

We are proud of making such a versatile product. It cures everything from radio interference to rats.

Take a look at "next year's models" of EHV hardware assemblies

It doesn't seem long ago when a phase on a transmission line was one conductor, and when high voltage was 230 kv. One measure of the rapid progress of the industry is to see engineers now investigating hardware to support five or six conductors, possibly for million-volt transmission. What a line this would make!

O-B presently has in fully tooled condition, for regular manufacture, complete hardware assemblies for two, three, and four conductors, combined with single or V-string insulation. The four-conductor version has an option of twin V-strings.

Over 1,000 miles of 735-kv line is now under construction with this latter design. All embody the unique feature of corona control, reducing ring requirements. All are in extensive commercial service today.

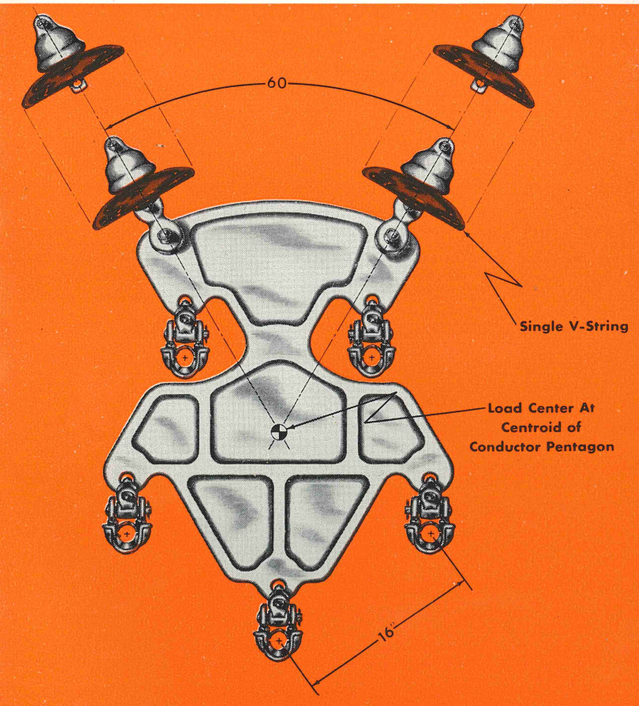
While no one yet has required anything more elaborate, we thought you might be interested in a preview of preliminary designs for five and six conductors. Based on our experience in developing and manufacturing hardware for bundles up to four, the additional conductors present no insurmountable technical problems. (After all, 40 years ago we built and operated a bundle of 42 conductors in our High Voltage Laboratory)

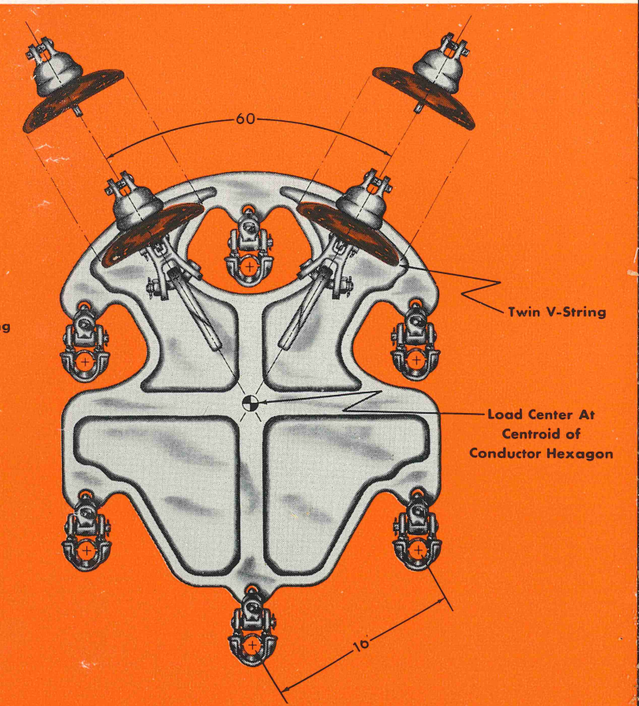
And, if these multiple-bundles are destined for million-volt service, we have the facilities on hand today to tests such a line in all of its electrical states: 60-cycle corona, RIV, lightning flashover, and switching surge flashover. This can be done at full scale in a natural outdoor environment.

In the fast-moving business of EHV, you can't stay just even . . . you are either behind the times, or ahead. We thought you might like to take a look at "next year's models."

Five-conductor yoke and insulator assembly. As drawn, this is intended for support with single V-strings, but twin strings could easily be substituted. This assembly retains the O-B features of excellent stability, adaptation to all forces of distortion, and corona-controlled design that eliminates rings.

For six conductors, this yoke is designed to be supported with V-strings. Static weight of such a conductor bundle could reach seven to ten tons. Addition of wind and ice loadings, and safety factors, would normally call for double strings. The hexagonal bundle would have exceptionally high electrical efficiency.





OHIO BRASS MANAGEMENT REPORT

Industry can solve the case of the "obsolete senior"

BY ROGER A. BLACK
PRESIDENT, OHIO BRASS COMPANY

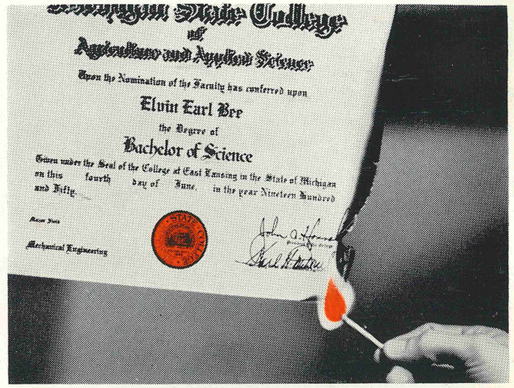
It might happen at some graduation ceremony in June. The engineering school senior accepts his diploma, walks off the platform, and turns perplexed to his parents: "What am I going to do? My education is obsolete." Farfetched? Not if you believe the comment by a junior engineering student recently reported in a Cleveland newspaper. "Things I learned in my sophomore year are already obsolete," he said.

ACCORDING TO AUTHORITIES quoted in the same article, the problem has developed because there is more than ever to learn. The world's store of knowledge doubled between 1750 and 1900, doubled again from 1900 to 1950, again between 1950 and 1960, and will double a fourth time by 1968. "It's a race between graduation and obsolescence," according to one educator. All this poses a serious dilemma. Theoretically, at least, people who want to keep their education up to date would have to spend their entire life in school and never have the opportunity for practical application of their knowledge.

I THINK THE ANSWER LIES, as always, in developing quality people who have the creative approach to practical problems. Regardless of education, one man can be obsolete at 22 while another is still going strong at 80.

WHEN WE LOOK AT EXAMPLES in our company of creativity at work, we see that it is not the exclusive province of the young or the highly educated, at least highly educated in the academic sense.

TWO YEARS AGO we put an automated molding machine in our malleable iron foundry. Despite the soundness of its design, it didn't produce up to our expectations until our engineers studied it and



made half a dozen significant refinements. Our men were electrical, not mechanical, engineers as were the men who designed the machine. But they studied the environment in which the machine had to operate. And their simple, but highly creative, suggestions followed. Their creativity didn't add much to the world's burgeoning store of knowledge. It did boost production and cure a lot of headaches.

MY POINT WOULD BE that we all need as much education as we can get. But education must go on in a meaningful way outside the classroom. It's management's job to provide the incentive and atmosphere for continuous learning, and practical creativity will surely follow. And our obsolete senior will have no problem.

747-H

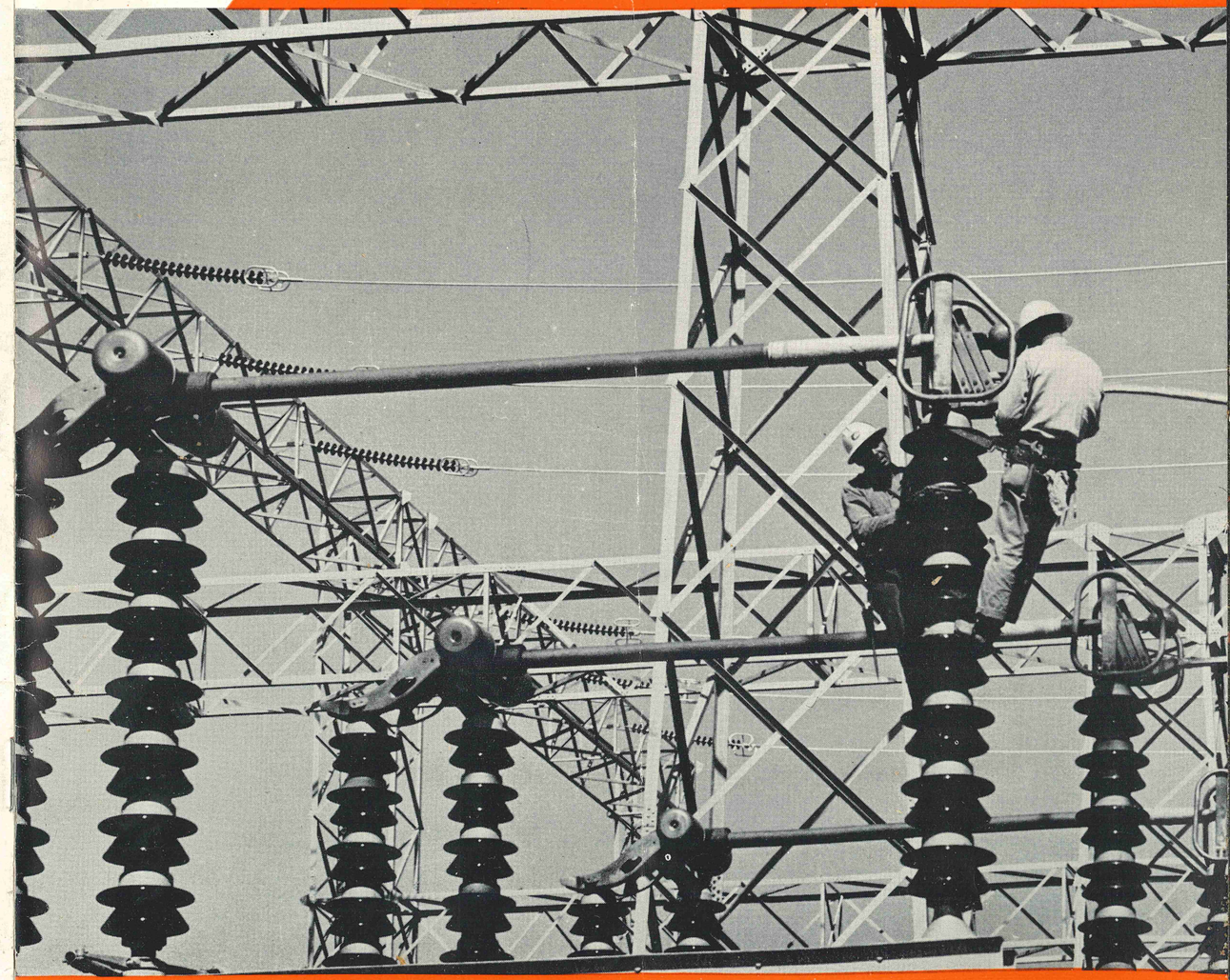
OHIO BRASS COMPANY • MANSFIELD, OHIO
Canadian Ohio Brass Co. Ltd. • Niagara Falls, Ontario

OHIO BRASS

6664-H Printed in U. S. A.

O-B Hi-Tension News

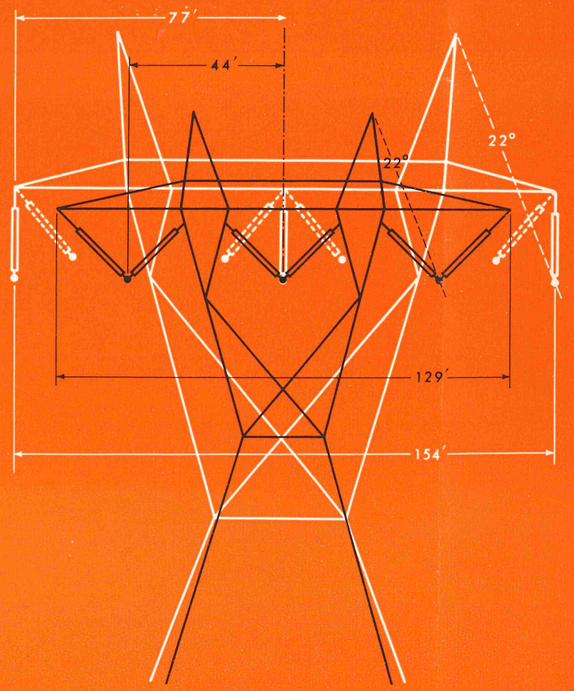
APRIL 1966



Improved characteristics for O-B stacking pincaps

Compact construction with V-strings reduces cost of structures

Resulting closer phase spacing also increases power-handling capacity of line



It sometimes happens that V-string construction of transmission lines saves so much land . . . and so many other items associated with land, such as clearing and maintenance . . . that another big category of savings is given only casual notice; namely, towers. Yet, on some EHV lines, V-strings have cut as much as a million dollars off this item. And, in doing it, they have increased the power-handling capacity of the system to gain even greater value.

Conductor restraint is the basic reason for the compact construction possible with V-strings. Because there is no sidesway at the tower, conductors may be permanently positioned at their minimum electrical clearance. This has its greatest effect on the center phase, permitting a radical reduction of size of the tower "window."

Such size reduction shortens the crossarm. Members may be reduced in weight and number. A shorter, lighter crossarm calls for corresponding economies in the leg portion. All told, a V-string tower will often fit well inside an equivalent tower for the support of free-swinging insulator strings, as the accompanying drawing shows.

Tower material must be moved to the right-of-way and later erected. Especially where long distances or rough terrain are involved, tons of tower can become a considerable factor in transportation. If structures must be flown in by helicopter, even pounds are important. And no matter how the tower arrives at its site it must be erected. Number of pieces and weight to be handled determine how many structures can be finished in a day. A host of details must be considered in the question of transportation and erection, but they favor the smaller V-string tower.

Naturally, there are so many variables in this question that we cannot present any general estimate of saving. From experience, however, a reduction of at least 10 per cent in erected tower cost is a reasonable expectation, and has often gone considerably higher.

Closer phase spacing, inherent with V-strings, produces a permanent improvement in power-handling capacity of a transmission line. Since most EHV projects are designed for maximum efficiency, this becomes a very attractive asset.

While resistance is present in any line, it is less of a factor at EHV levels than inductive reactance. Reactance imposes a limit on the amount of power a line will accept. Reactance is directly related to phase spacing . . . the closer the phases are positioned, the lower the reactance. With all other specifications the same, closely grouped phases will permit the line to handle materially more power. In the example of towers shown here, twin conductors at 500 kv will accept about six per cent more power with V-string construction.

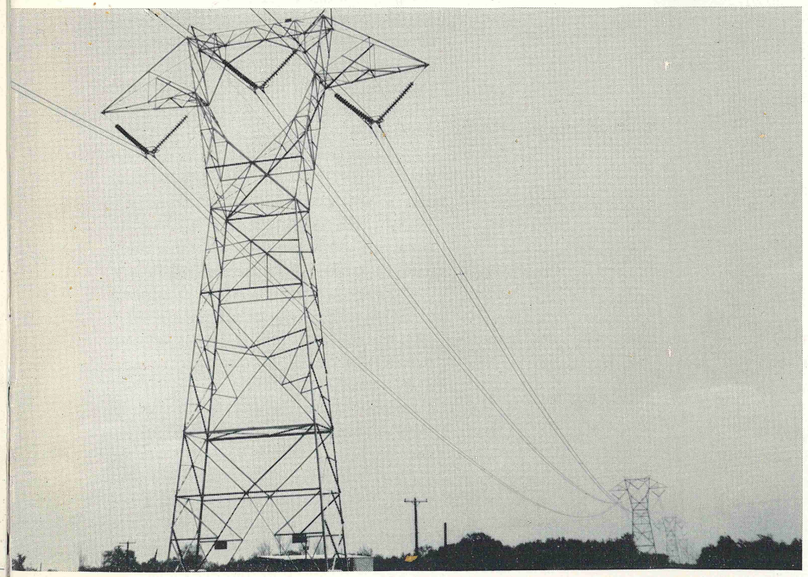
To evaluate the effect of inductive reactance, the design details of an individual line must be considered. This can be done only by the engineers of the power company planning that line. It will be found, however, that the somewhat tedious calculation of inductive reactance will be well justified in a more realistic set of facts relative to the merits of V-strings vs free-swinging single insulator strings.

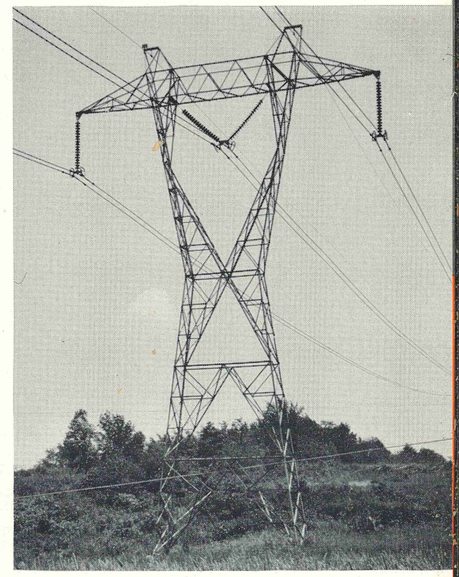
Tower designers will naturally be confronted with questions from their management regarding relative costs of the two kinds of construction. While they can be estimated accurately, there are a few generalities that may also be of interest. The three extra strings of insulators required for V-string construction can almost always be covered by the saving in tower cost . . . often several times over. Even where land is quite cheap, a reduction in right-of-way width of only 20 to 30 feet should defray the extra cost of insulation, and V-strings usually save more land than this (eight feet of right-of-way equals one acre per mile). Owners of a 500-kv line now under construction tell us that V-strings paid for themselves simply through reduced clearing cost. In short, your case will be exceptional if V-strings on a major EHV project do not show well over a million-dollar clear saving . . . plus the attractive prospect of delivering more power.

LEFT - With the same factors of electrical clearance and shielding angle, a typical schematic tower for single-string, free-swinging insulation (white) is superimposed on an equivalent tower for V-strings (black). This demonstrates the common assumption that a V-string tower will fit well inside its single-string counterpart in the majority of cases. Saving of material, weight, transportation and erection costs, through use of the smaller tower, are obvious. By reducing phase spacing from 77 to 44 feet, the line will have greater power-handling capacity as a result of lower inductive reactance.

RIGHT - Since this 345-kv line crosses large tracts of expensive suburban real estate, V-strings were used to their maximum advantage in restricting the right-of-way to only 100 feet. A second advantage in extremely compact towers is higher transmission efficiency.

FAR RIGHT - As mentioned in the text, V-strings exert their principal effect on the size of the tower window to accommodate the center phase. Size and dimensions of this tower have been reduced with the employment of only one V-string.



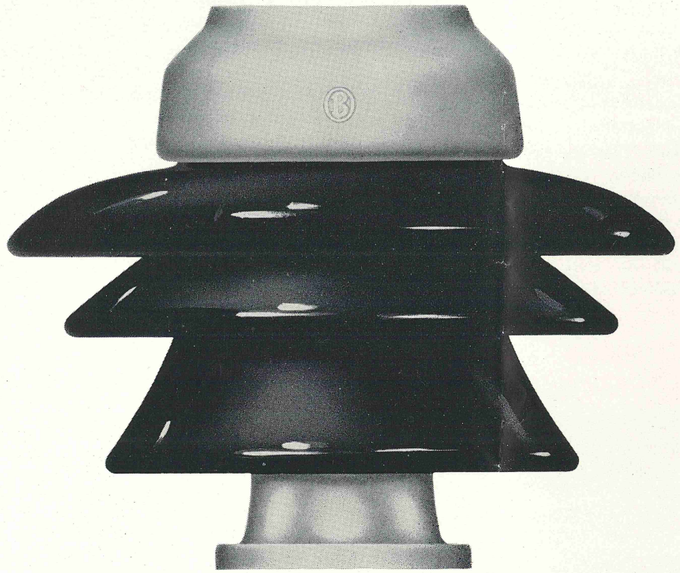


Hi-Tension News
APR. 1966, VOL. 35, NO. 4

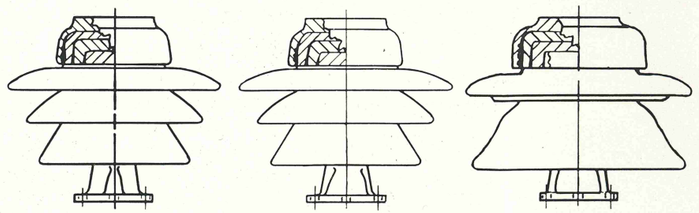
ON THE COVER - Uniform stacking arrangement of O-B pincap insulators at 345-kv substation simplifies maintenance requirements through station-wide interchangeability.

OHIO BRASS CO., MANSFIELD, OHIO

Improved characteristics and availability of O-B high strength stacking pincaps broaden application possibilities



High-strength stacking pincap 43990 is three-skirted unit with alumina-body porcelain for increased mechanical and electrical rating.



Pincap 43990, when used in mixed stacks, combines the desirable electrical characteristics of the 31152 insulator with the higher strength rating of the 30575 design.

High strength pincaps (O-B Catalog numbers 31152 and 43990) are at present available on reasonable delivery schedules for use in constructing substation insulation.

Under these circumstances, it is appropriate to review salient characteristics of pincap insulators, including several improvements which have become effective since specifications were last published. The inherent versatility of pincap insulators simplifies station planning through their convenience in adaptability to bus work and equipment. Cost, appearance, BIL ratings, cantilever strengths, and stack deflections can be extensively controlled by station planners through the many options which are available in the selection of uniform or mixed stacks of pincap insulators.

A particularly prominent example of the advantages to be gained through mixed stacks involves O-B's 43990 high-strength pincap insulator, which was announced several years ago as a design combination incorporating certain desirable stacking characteristics of standard pincap models 31152 and 30575. Since the introduction of the 43990 pincap, it has been recommended for use in place of the 30575 insulator in mixed stacks with 31152 units to achieve a substantial improvement in the stack's electrical characteristics. Equal cantilever strength is maintained and a significant savings in cost is realized.

Physical dimensions of the 43990 pincap insulator match those of the 31152 units, while the 30575 unit has a porcelain diameter one inch greater. Both 31152 and 43990 pincaps are of three-skirted construction and have inherent capacitance of 70 picofarads. The 30575 pincap is of two-skirted construction and has an inherent capacitance of approximately 135 picofarads.

Inherent capacitance of individual pincaps is an important factor in mixed stacks, because it determines the voltage division existing across individual units. Since the charging current is approximately equal (except for stray losses) for all units in an insulator stack, voltage across each unit is inversely proportional to the unit's inherent capacitance. Consequently, when a mixed stack of pincaps having the same capacitance is being considered, the electrical rating is not affected. Conversely, when a mixed stack incorporates pincaps having different capacitances, the electrical rating may be reduced when the high capacitance unit is used at the ground end.

Cantilever strength rating of the 31152 pincaps is substantially less than that of the 30575 units. This limitation has been overcome in the 43990 pincaps where the high-strength porcelain body of the three-shell construction is combined with heavier hardware to provide the same strength rating as the 30575 units.

Stack deflection values for the 43990 pincap insulator have been significantly improved since its introduction. Deflection ratings closely approach those of the 30575 units, as indicated in the tabulated characteristics to the right.

To summarize present data on 31152, 30575, and 43990 pincap insulators, some general comparisons can be made.

A uniform stack of 31152 pincaps still represents the lowest-priced option, but also carries the lowest strength rating and the highest deflection. Uniform stacks of 30575 and 43990 pincaps both have the highest strength rating, but the higher-cost 30575 pincaps are much heavier in weight and have only slightly less deflection.

Mixed stacks of 31152 and 30575 pincaps have the same cantilever strength ratings as corresponding mixed stacks of 31152 and 43990 pincaps, but the lower unit price of the 43990 insulators results in a definite cost advantage for the 43990 combinations. While the 30575 pincap combinations obtain better deflection ratings, it is also true that their higher inherent capacitance necessitates some reduction in stack BIL.

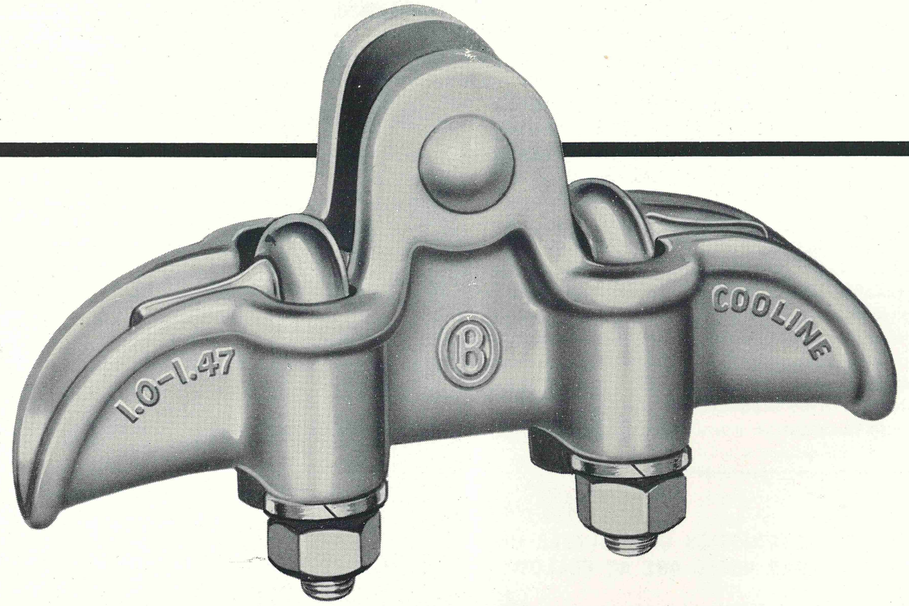
CHARACTERISTICS OF A SINGLE UNIT NUMBER 43990 ARE AS FOLLOWS:

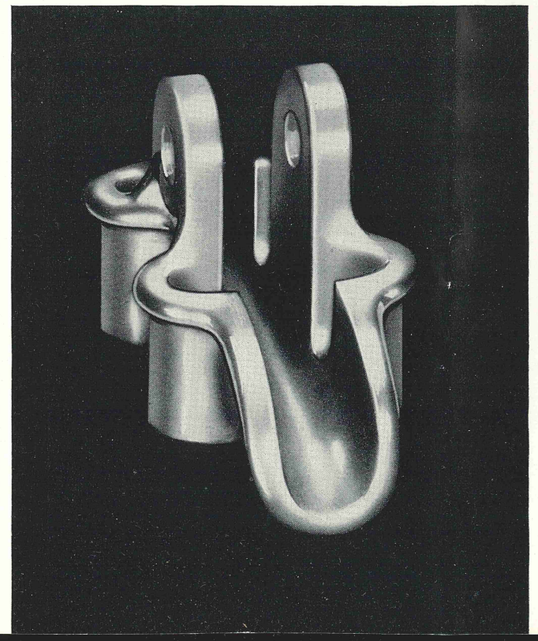
BIL (Impulse withstand)	210 kv.
Flashover voltage, 60 cycle, dry	160 kv.
Flashover voltage, 60 cycle, wet	95 kv.
Flashover voltage, impulse critical, positive	235 kv.
Flashover voltage, impulse critical, negative	290 kv.
60-cycle withstand voltage, 1 min., dry	115 kv.
60-cycle withstand voltage, 10 sec., wet	75 kv.
RIV, test voltage	22 kv.
RIV, maximum microvolts at 1000 kc.	100 mu-v.
60-cycle oil puncture	215 kv.
Cantilever strength, base mounted, upright	10,000 lbs.
Cantilever strength, top mounted, underhung	6,000 lbs.
Tensile strength	25,000 lbs.
Torsion strength	90,000 inch-lbs.
Compressive strength	75,000 lbs.
Leakage distance	33 inches
Dry arcing distance	14¾ inches
Net weight	85 lbs.
Packed weight	99 lbs.
Bolt circle diameter	5 inches

TABULATION OF STACKING DATA 31152, 30575 AND 43990 PINCAPS

Stack 31152	Stack 30575	Stack 43990	BIL, kv.	Cantilever Strength lb.	Deflection in/100 lb.	Height, Inches
2	—	—	350	3000	.0110	32½
1	1	—	325	4500	.0067	32½
1	—	1	350	4500	.0081	32½
—	2	—	350	4500	.0061	32½
—	—	2	350	4500	.0077	32½
3	—	—	550	1700	.035	47
2	1	—	525	2900	.025	47
2	—	1	550	2900	.028	47
—	3	—	550	2900	.020	47
—	—	3	550	2900	.025	47
4	—	—	750	1200	.080	61½
3	1	—	725	1700	.060	61½
3	—	1	750	1700	.068	61½
2	2	—	710	2000	.050	61½
2	—	2	750	2000	.061	61½
—	4	—	750	2000	.045	61½
—	—	4	750	2000	.058	61½
5	—	—	900	910	.150	76
4	1	—	875	1200	.122	76
4	—	1	900	1200	.132	76
3	2	—	860	1450	.102	76
3	—	2	900	1450	.120	76
—	5	—	900	1450	.087	76
—	—	5	900	1450	.110	76
6	—	—	1050	750	.260	90½
5	1	—	1025	910	.213	90½
5	—	1	1050	910	.230	90½
4	2	—	1010	1170	.185	90½
4	—	2	1050	1170	.212	90½
—	6	—	1050	1170	.150	90½
—	—	6	1050	1170	.190	90½
7	—	—	1300	620	.410	105
6	1	—	1275	750	.340	105
6	—	1	1300	750	.360	105
5	2	—	1260	910	.293	105
5	—	2	1300	910	.330	105
4	3	—	1230	1000	.265	105
4	—	3	1300	1000	.312	105
—	7	—	1300	1000	.230	105
—	—	7	1300	1000	.290	105
8	—	—	1470	525	.600	119½
7	1	—	1445	620	.520	119½
7	—	1	1470	620	.550	119½
6	2	—	1430	750	.450	119½
6	—	2	1470	750	.500	119½
5	3	—	1400	900	.403	119½
5	—	3	1470	900	.470	119½
—	8	—	1470	900	.340	119½
—	—	8	1470	900	.430	119½

O-B offers investment insurance for $3.50

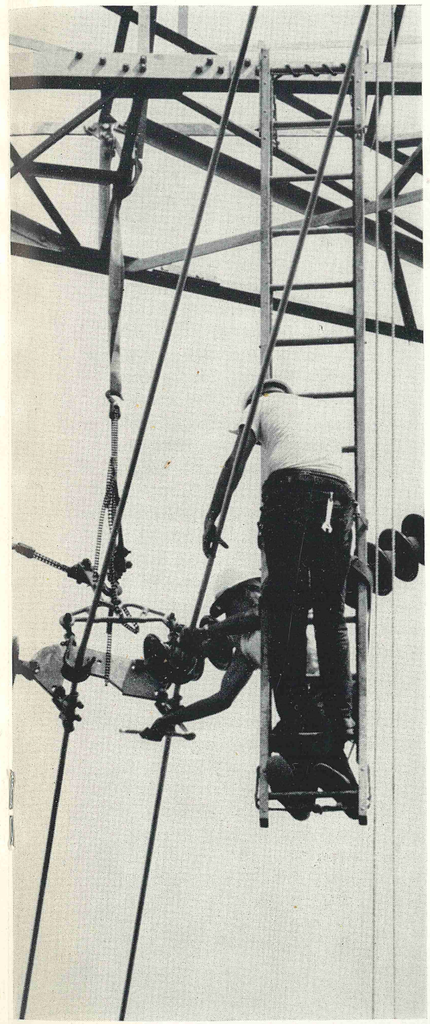




Here's O-B's $3.50 power-line investment insurance - the regular Cooline[R] suspension clamp. It's the one conductor support for all power systems from 34.5 to 345 kv.

Casting of all O-B Cooline[R] suspension clamps in modern manufacturing facilities results in consistent reproduction of the controlled-radius design to assure you optimum performance on your line.

Linemen need no special training or tools to install O-B's regular Cooline[R] suspension clamps. Here they tighten the clamp securely with a socket wrench at an angle position on a midwest 345,000-volt transmission line .



Would you invest $3.50 to protect your power-line investment at each support point? That's the price of the average-size O-B Cooline[R] suspension clamp to support power systems from 34.5 to 345 kv. Let's take a look at what you get for your $3.50.

First, you get your money back! Cooline[R] clamps are nonmagnetic, cast of either bronze or aluminum. Hysteresis or eddy current losses, which cause heating in ferrous clamps, are reduced to a negligible level. Your clamp and conductor remain cool, power losses are substantially reduced, and transmission efficiency is increased when you install O-B's Cooline[R] suspension clamps. Savings derived from the increased power delivered at receiving end will often pay for the complete cost of the clamps two or three times during the life of the line.

Another form of built-in insurance furnished by O-B Cooline[R] suspension clamps is the controlled-radius design. During the past 50 years, O-B engineers made detailed studies of clamp requirements and performance under normal, static, and dynamic loading conditions on hundreds of lines at all voltages. These studies revealed the design criteria for the optimum clamp to match the performance requirements of almost all lines, and resulted in development of O-B's exclusive controlled-radius design principles. Now, the O-B development engineer checks your line's requirements when he receives your order to make certain the O-B clamp you selected has the correct seat size, seat radius, and take-off angle to fit your needs. Basically, your O-B clamp is matched with your line to assure optimum performance. And, you get the additional benefit of a performance-proved clamp with known reliability because O-B Cooline[R] clamps have a 15-year history of successful operation.

A third type of investment insurance is found in the manufacture of O-B's Cooline[R] clamps. Both aluminum and bronze types are cast in modern manufacturing facilities. Rigid quality control and inspection during the manufacture and finishing of Cooline[R] clamps insure delivery of a smooth-surfaced cradle to fit your exact conductor size and line requirements.

Use of steel, permanent molds in casting O-B's aluminum suspension clamps results in consistent design reproduction time after time. Controlled cooling and heat treating assure uniform metallurgical structure throughout each clamp for maximum strength. And, application of a quality aluminum clamp to your aluminum conductor prevents electrolytic action which can occur between dissimilar metals.

All Cooline[R] clamp keeperpieces are also designed and manufactured to fit a specific range of conductor sizes, and receive the same careful inspection before shipment. Clamp and keeperpicce fit together naturally to form a snug fit with the conductor. Close fit between clamp, conductor, and keeperpiece assures uniform distribution of keeper pressure to prevent distortion of conductor strands — additional insurance to protect your investment.

Installation of O-B's regular Cooline[R] suspension clamps is convenient and simple. Your linemen need no special tools or training to make a correct and permanent attachment of clamp to conductor. Four large U-bolts in the keeperpiece fit into four holes in the clamp body. One lockwasher and one rounded nut are threaded on each bolt protruding through the clamp body, then snugged tight with a socket wrench to complete the installation. Marking each clamp body with its appropriate conductor size protects against accidental installation of the wrong clamp.

If you're in the planning stages of construction on a line from 34.5 to 345 kv, pull out your O-B Transmission & Distribution Hardware Catalog 44. Turn to page 10 and check which O-B clamp fits your needs. (Ultimate strength ratings range from 18,000 to 25,000 pounds.) If you have questions, call your Ohio Brass district manager. He'll be glad to help you select the exact performance-proved O-B suspension clamp to protect your line — and O-B yokes, fittings, insulators.

This is our biggest investment in pessimism

Facilities are available to test Thorex arresters for an event that might happen once in 14,300 years

Lightning arresters have recently become such an important factor in switching surge control on EHV systems that their basic function . . . lightning protection . . . is taken for granted by many users. This is all right, providing O-B doesn't take it for granted. How do you test for severe lightning attack . . . do you actually make lightning? The answer is "yes."

If simulated lightning is used for arrester testing, what should be its magnitude? This question falls into the general category of service duty testing, involving high-current, short-duration impulse discharges. Arrester class . . . distribution, intermediate, or station . . . and to some extent, voltage rating within its class, determines the maximum testing current applied to an individual specimen. This is guided by a highly accepted and dependable body of statistical data. At the far end of this data, it recognizes the possibility of an arrester being subjected to 100,000 amperes of lightning current once in 14,300 years.

It may be considered ultra-pessimistic that we installed in the O-B High Voltage Laboratory a special impulse generator capable of delivering more than 100,000 amperes. Whenever production of such a massive test discharge is required, it is simply a matter of adjusting the generator circuit. The equipment to perform such tests is not only quite specialized but has been of considerable interest to laboratory visitors.

To start with, it would be highly impractical to produce these currents with any conventional form of research surge generator. Such requirements don't fit the concept of this type of generator. And even if a piece of all-purpose equipment were available, it would be monopolized for lengthy periods in arrester testing and prevented from working on a busy schedule of EHV transmission studies. For these reasons, a separate generator was built, including its own special power supply and instrumentation.

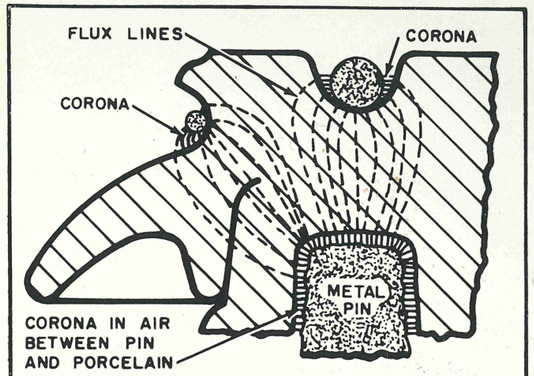
Especially when working in the range of its maximum output, the discharge of this generator is impressive. The noise is like heavy artillery. Specimens under intentional destructive test fail with explosive violence, propelling fragments at dangerous velocity. To control noise and confine debris, a strong enclosure completely surrounds the test stand. Its deeply scarred walls attest to its value. These same walls help reduce noise.

Another advantage of the enclosure is the natural center it forms for the closely clustered high-current capacitors that completely surround the structure and keep length of leads at a minimum.

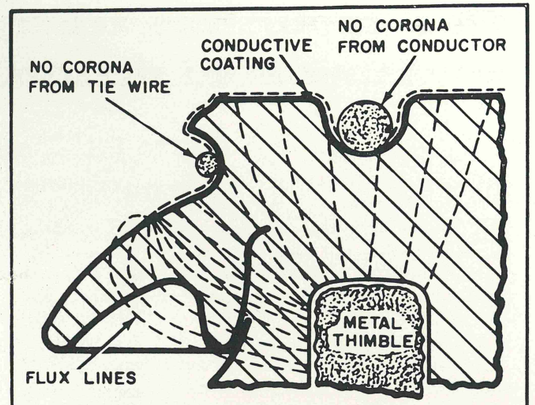
Most of us find it difficult to visualize 100,000 amperes in terms of force . . . it is simply a lot of amperes. An interesting phenomenon of this generator suggests some of the unsuspected forces involved. For test connections, heavy flexible copper braid is used. This material is woven cylindrically and then pressed flat. A single discharge causes the piece of braid conducting the current to expand back to its hollow cylindrical form.

When laboratory visitors ask us what this generator is for, we sometimes explain it is our biggest investment in downright pessimism . . . it can duplicate an event that might occur once in 14,300 years.

Lightning discharges as high as 100,000 amperes may be produced on this special impulse generator for testing arresters in the O-B High Voltage Laboratory. The heavy enclosure around the test stand reduces the almost deafening noise and confines flying particles during destructive tests.



On ordinary pintype insulators, an electrostatic field forms between the conductor, tie wire, and metal pin which develops stress concentration at tie wire and conductor to produce excessive RIV and corona.



After application of O-B's Number 608 Conduction Paint, the electrostatic field is distributed over a broader area to reduce RIV and eliminate corona when the line is energized.

Modernize "old" insulators with O-B's number 608 conduction paint

During a recent modernization program of distribution lines, one O-B customer removed old pintype insulators which produced high RIV levels after he raised his primary distribution voltage. The insulators had adequate dielectric strength, but incipient arcing produced excessive RIV and corona. Naturally, he couldn't justify discarding several hundred insulators, so he presented his problem to his O-B district manager.

Recognizing the "troublesome" pintypes as pre-Silentype units without conduction glaze, the O-B district manager directed his customer to Page 17 of O-B T&D Insulator Catalog 42. Listed there is the solution to excessive RIV on older insulators -- O-B Number 608 Conduction Paint. Applied to the pinhole and head of an old pintype insulator, Number 608 Conduction Paint substantially reduces generated RIV on the insulators to levels comparable with units having conduction glaze.

When an insulator is installed on a line and energized, a difference of potential exists between the metal pin, conductor, and tie wire to produce an electrostatic field. This field tends to be intense at the contact points on the insulator to produce high RIV levels and corona. On modern O-B pintype insulators, the Silentype conduction glaze covers the insulator head and pinhole to distribute the stress over a broader area and reduce the concentration. O-B's Number 608 Conduction Paint does the same thing for old insulators made before development of the Silentype glaze.

Covering the head section and pinhole of old pintypes with Number 608 paint results in a conductive coating which will eliminate excessive RIV and corona. Number 608 paint adheres closely to the insulator surface and will not chip, peel, or form spots to develop a stress point. To coat a unit, use a brush or "swab-like" instrument dipped into the paint and apply to the head portion of the insulator. Taper the coating off a little less than halfway down the insulator's top surface to prevent an abrupt end to the conductive portion of the unit. Then, coat the upper half of the pinhole thoroughly. Let the units dry for several hours, and put them back up on the job.

Convert your old insulators for use on today's higher-voltage distribution lines. Order O-B's Number 608 Conduction Paint from your O-B district manager. And, order Number 608 solvent to clean brushes and remove any unwanted spots from your pintypes. Ask your O-B district manager for further information, or write: Ohio Brass Company, 380 North Main Street, Mansfield, Ohio 44902.

O-B's Number 608 Conduction Paint is available in quart and gallon cans, clearly labeled for easy identification. Number 608 solvent comes in pint and quart cans, and permits removal of unwanted spots from insulators and excess paint from brushes.

How to cut the trouble and cost of contaminated distribution insulators

How much does it cost to clean contaminated insulators on a distribution system? There are dozens of answers, depending on severity of the trouble, how much is charged directly against the job, and what is absorbed in miscellaneous expenses. But, however you account for it, the money must be spent.

Three pieces of equipment are necessary: a high-pressure jetting pump with special hose and nozzle, a water supply such as a tank trailer, and some type of safe aerial equipment to put men up to their work. If the full hourly charge for this equipment is allocated to the job, it could easily amount to $25 per pole, perhaps more.

Wages for drivers, ground crew, and linemen may come close to equaling that figure.

To be coldly realistic we tried the question in a different way. Ignoring all charges for equipment, and assuming wages for only four men, could the equipment be moved from pole to pole, the work bucket positioned, and insulators cleaned for $10 per pole? This was asked the O-B Live Line Department which has efficient equipment and intimate knowledge of the work. The answer was, "We'd hate to promise it, let alone maintain this rate for a full day."

Regardless of cost, however, when leakage begins to occur over the surface of a contaminated insulator, it is no longer a question of do we or don't we clean them. It's only a matter of WHEN do we clean them?

It is the word "when" that we would like to explore in somewhat more detail, because "when" is closely related to the expenditure of money.

Various measures have been tried to postpone or possibly eliminate cleaning of distribution pintype insulators. One of these is over-insulation. Larger insulators, rated three or four times normal line voltage, have longer leakage surfaces and deeper petticoats. For moderate contamination these may establish sufficiently long paths so that critical surface leakage may never develop, or at least develop very slowly. This, of course, is importantly aided by clean, relatively dry areas up under the petticoats, which limit the flow of surface leakage currents.

Many factors influence the economy of over-insulation: magnitude and tenacity of the contamination, and degree of conductivity of the deposit. There is little point to buying only a minor improvement with a major increase in insulation cost. But over-insulation has worked admirably in some cases, and is well worth a modest experiment.

Another measure, dependent somewhat on the nature of the contaminant, is the use of post-type insulators. The post has the advantage of fully exposed surfaces which lend themselves to natural rain washing. If the deposit is soluble in rain, this design can be very effective. If not, the fully exposed surfaces become totally coated and constitute an unrelieved leakage path. It must be realized that unusually long leakage length can be obtained quite readily in a post, but if the surface becomes uniformly contaminated with a tenacious, conductive film, even this extra length loses much of its value.

Some utilities follow the practice of changing-out contaminated insulators, cleaning them, and returning them to stores. This cleaning is done by shop labor. Granted this requires less mechanical equipment and fewer men on the job, but it is doubtful if all the insulation on two poles per hour can be changed-out, hot, including allowance for time in transferring and repositioning aerial equipment. Again, members of the O-B Live Line Department didn't care to commit themselves to any complete change-out figure as low as $10 per pole.

It is reasonable, and probably conservative, to say that $10 per pole represents a very low "par for the course" in dealing with contaminated insulators. And this may be repeated at frequent intervals.

At 7.2 kv, for an additional insulation cost of $3.21 per pole and at 13.2 kv, for an additional insulation cost of $8.37 per pole, the problem of cleaning can be considerably postponed, and stands a fair chance of being eliminated. This is done by the use of Fogbowl insulators. If they can save only one cleaning operation, their cost will be recovered. Actually they may never require cleaning, but, under the worst of conditions, they will extend periods between needed attention and thus save many times their purchase price.

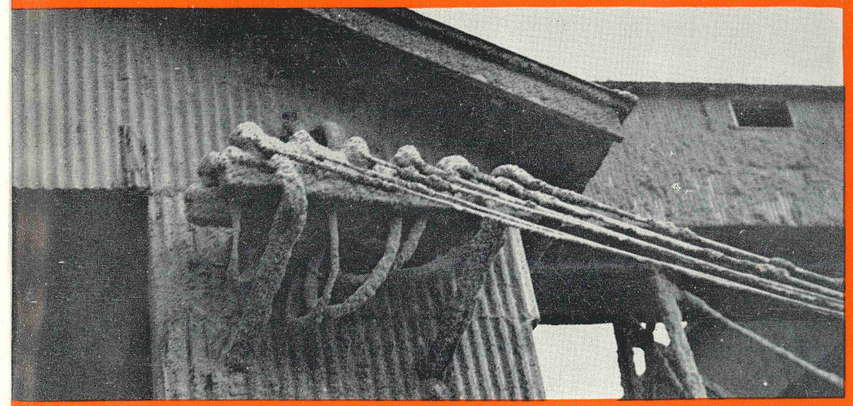
Fogbowls consist, basically, of a pintype insulator completely surrounded by an integral porcelain shroud. This shroud provides effective protection for the insulation underneath. Contamination on the outer surface of the shroud is harmless. It is difficult for deposits to form on the protected portions of the insulator. Even if some freak wind condition might eventually result in contaminated inner surfaces, it would be a very slow process. And even so, these surfaces would remain dry because of the complete shield provided by the shroud.

We in the insulator business have lived so close to the problem of contamination that we are the first to admit a universal cure-all has yet to be invented.

In most cases, however, contamination can be brought under tolerable control. Various operators prefer various methods which are sometimes dictated by nature of the contamination . . . primarily whether it will yield to the washing action of rain. This factor can control consideration of over-size insulation or the use of posts. In more severe cases the Fogbowl insulator offers effective relief.

"What do you do in a case like this?", is a question that can keep an insulator manufacturer awake nights. After a relatively few months exposure to cement dust, this condition developed. Perhaps a delaying action might be fought with gross over-insulation. Because of its total exposure, a post type would offer no solution. It would probably be ultimately the most economical to acquire the necessary land and relocate the line to the windward side of the source of contamination.

A less severe cement deposit. Over-insulation in this case might be relatively effective in extending the time of insulator replacement (this contamination would not yield to ordinary field cleaning). As a substitute for extra insulation, the Fogbowl would likewise delay, but probably not eliminate, attention.

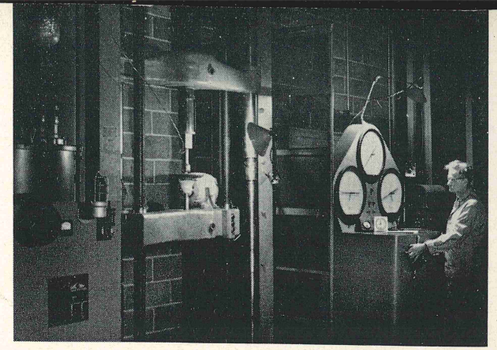


While the low voltage involved resulted in relatively minor trouble, a condition such as this offers a severe hazard. Here, the contaminant is asbestos fibres that adhere tenaciously and become conductive when wet. Multiple disc-type dead-end insulators that would provide almost infinite over-insulation would probably extend cleaning periods, but relocation of the construction would be the only permanent cure.

Contamination of the more conventional type. This consists of a film of deposit which, if washable, would indicate the use of post-type insulation. If the contamination were not too conductive, even though not washable, an over-size post might impose sufficient leakage distance to keep trouble under control for long periods. Insulators such as this are sometimes removed and brought in for shop cleaning. The Fowbowl would increase freedom from trouble.

monograph

#13



Mechanical and electrical load are applied simultaneously on assembled suspension unit.

Is the design being followed?

M & E test helps provide the answer

The combined mechanical and electrical test (pgh. 9.5.2 EEI Pub. No. TDJ-52, NEMA Pub. No. 140-1952; pgh. 5.2.1, ASA 29.1 -- page 141 O-B No. 28 catalog) on suspension insulators is a quality control test. Its purpose is to check on how faithfully the factory is reproducing the insulator design from the standpoint of mechanical and electrical strength.

In the test, mechanical and electrical load are applied simultaneously with the assembled suspension unit mounted in a tensile testing machine.

The electrical load is a 60 cycle voltage equal to 75 per cent of the dry flashover rating of the insulator. The mechanical load is started at zero and smoothly brought up to the failure point. The load is increased rapidly to approximately 75 per cent of rated strength of the insulator and at a slower rate from this point to failure. The rate of increase from 75 per cent of rating to failure is between 15 and 30 per cent per minute of the rated strength.

The test is a simple one. The result is expressed in two values, the strength at which the insulator failed electrically and the strength at which the insulator failed mechanically. Usually, the values are the same. Although it's simple, the test is one of the most significant we run, significant to both the customer and the manufacturer.

What's its meaning to the insulator buyer? He's interested in an insulator of a specific design, probably a design he knows has performed well in the past and one with M & E values suited to his particular line. He wants assurance that the insulator he buys is being produced within the limits of the predicted characteristics. The M & E test results show that he's getting what he wants.

Significant to both buyer and manufacturer is the value of the test as a check on manufacturing, all the way through assembly. It's a check on the porcelain, the glaze, the sand grip area, resilient coatings, hardware strength and contours. It shows whether the pin and cap are concentric and whether the insulator has been mishandled in any way.

It's also extremely valuable to us, the manufacturer, as a quality control measure. When the M & E values fall within predicted limits, we know the process and tooling are adjusted to correct levels. Variation is expected and isn't cause for alarm but an unusual variation trend is reason to re-examine the tools and processes to head off trouble before it develops into something that will reduce M & E value.

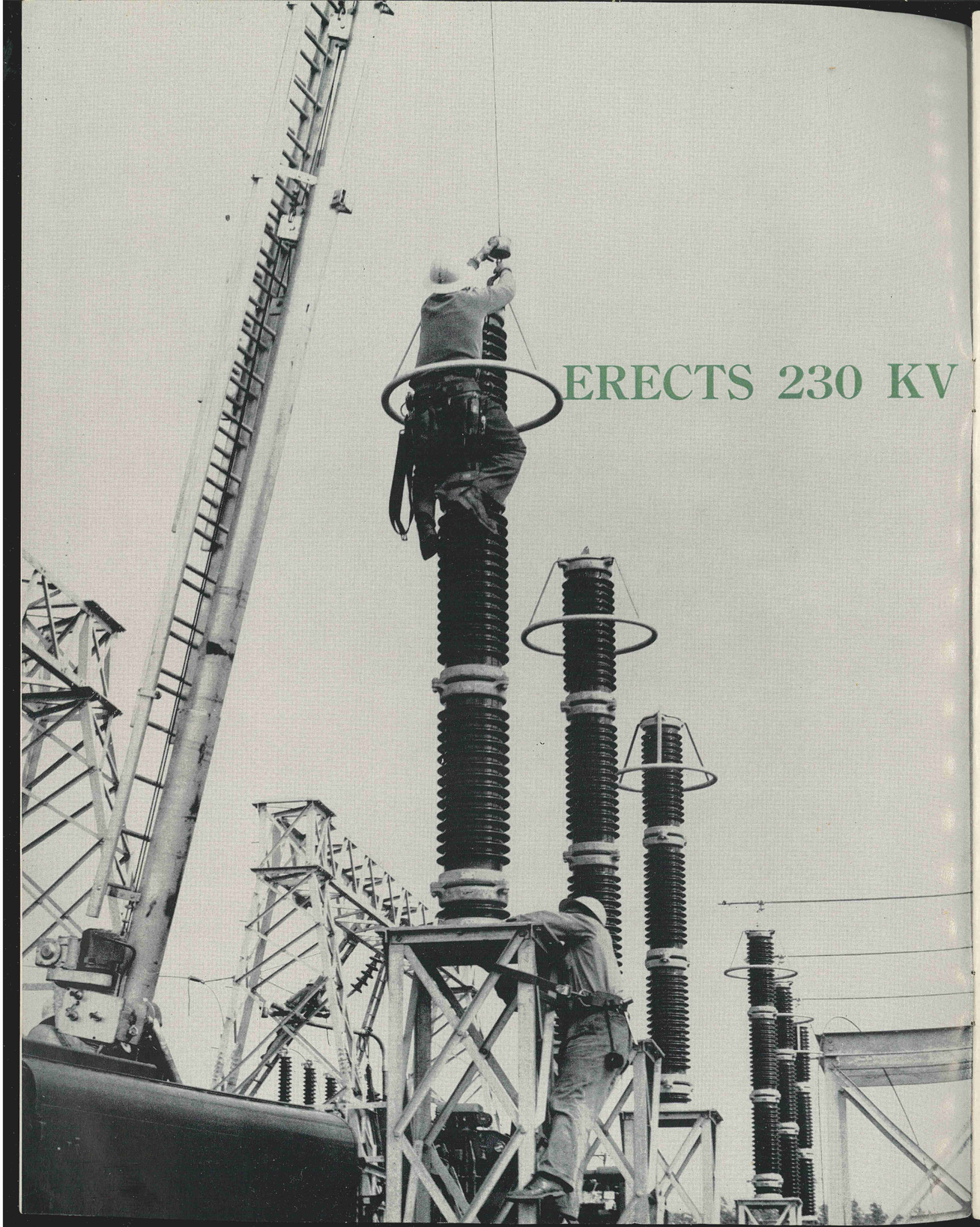
Don't make the mistake of using M & E strengths as the principal measure of an insulator's value. Design must also be considered. It's quite possible that one design would require higher M & E values to do the same job, because of a weakness in the design.

We're not striving especially for M & E values that are higher than rated strength. We're more interested in product uniformity since ability to stay within predicted characteristics is our primary goal.

Volume 25 • No. 12 Published by Ohio Brass Company, Mansfield, Ohio 5971-H Printed in U. S. A.

HI-TENSION NEWS

DECEMBER 1956



ERECTS 230 KV THOREX ARRESTER

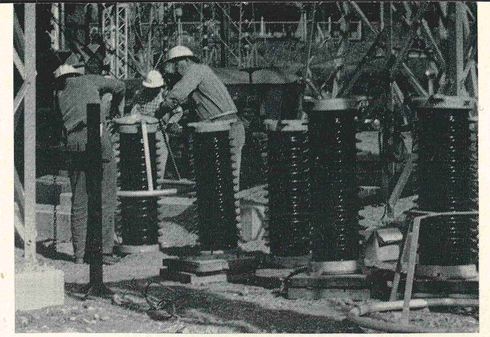
in one-third man-hour per pole

Fast installation is one more economy derived from thorex design featuring few large units . . .

This may be a record! Three men - two on the ground and a hoist operator - recently erected a 230-kv Thorex lightning arrester in **one-third man-hour per pole!** In other words, starting with the bare units, a pole was fully assembled and erected in seven minutes.

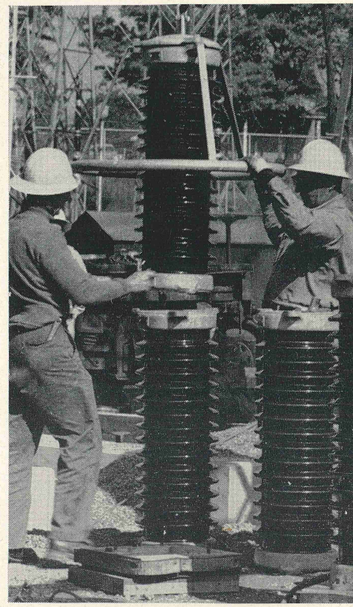
There were no special tricks used. The work was done in the Peckville Substation of Pennsylvania Power & Light Company, near Scranton, by the company's regular construction crew. Carrying the uncrated units to the work site and relocating the hoist naturally consumed added time, but all three poles were completed in well under one hour.

The simplicity of a self-supported arrester permitted the crew to devise an ingenious method of erection. The grading ring and cap were first bolted to the top unit. A clevis fitting was connected to the suspension lug on the cap. This made an easy attachment for the lifting hook. The assembled top unit was then raised into place on the second unit, and the bolted flange joint made-up. This pair of units was then placed on top of the base unit, and again bolted. These arresters are equipped with insulated sub-bases (a fourth unit from a labor standpoint), and the whole arrester was placed on the sub-base and

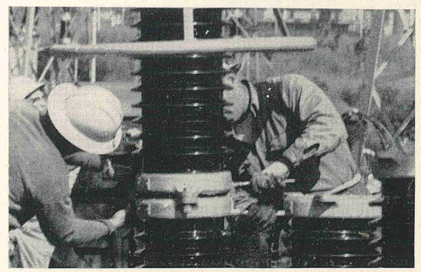


1 Grading ring and cap are bolted in place on top arrester unit. Hoist hook is attached by clevis to suspension lug on cap, and remains until work is completed.

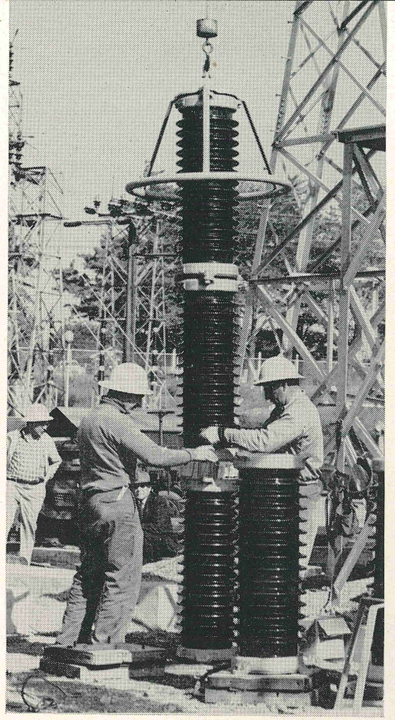
P. P. & L. crew



2 Assembled top unit is raised and positioned on second arrester unit.

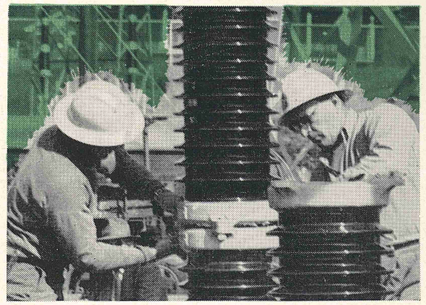


3 Connection between units by means of a three-bolt flange is conveniently made-up on the ground.

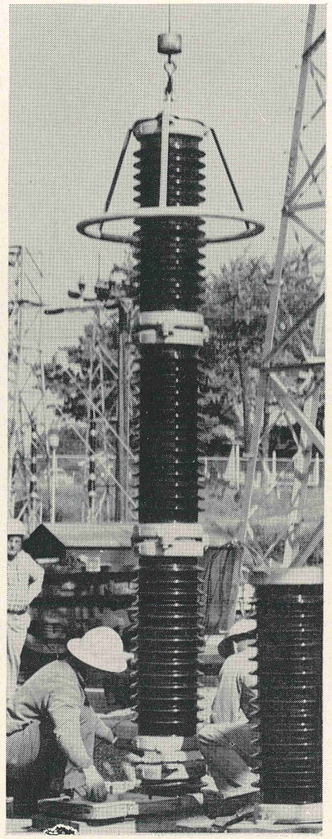


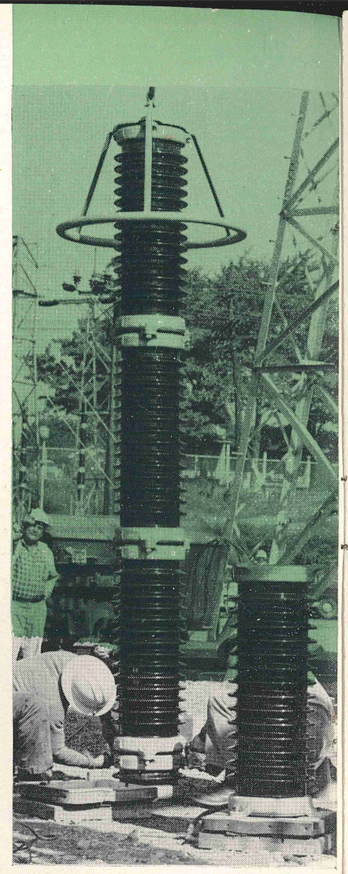
4

Top two units are moved into position on base unit.



5 Second flange connection is made with men still standing on the ground.





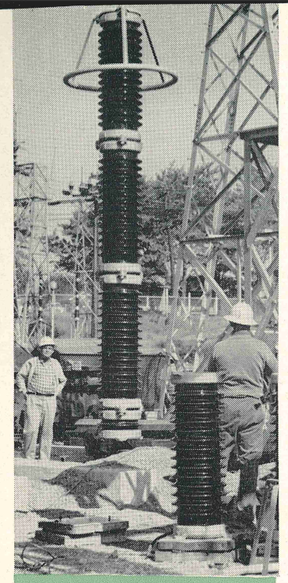
7 Bolted connection with the sub-base is made-up.

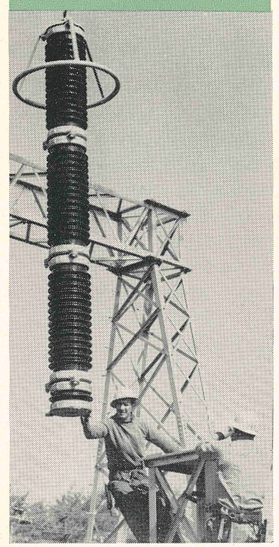
6

The complete arrester is put into place over the insulated sub-base.

bolted while still on the ground. At this point, the complete assembly was lifted to its elevated mounting base and, after tightening the attachment bolts, one of the men climbed the arrester pole and unhooked the hoist. The foregoing consumed, as we said, seven minutes from start to finish.

This fast method of construction was aided by several details of Thorex design. Few, large high strength units minimize the number of connection points in the stack. In this case only three arrester units constituted a 230-kv pole, to which was added an insulating sub-base. This results in a total of only three intermediate stacking connections. Including the cap attachment and base mounting, the crew had only 15 bolts to handle. Simple, strong, 3-bolt flange connections are the result of using heavy malleable iron end castings on arrester units. Probably the greatest aid to rapid erection, however, is the totally unsupported design of the Thorex arrester that requires no auxiliary bracing of any kind, and thereby eliminates all complications of assembly and adjustment of external members. Only the

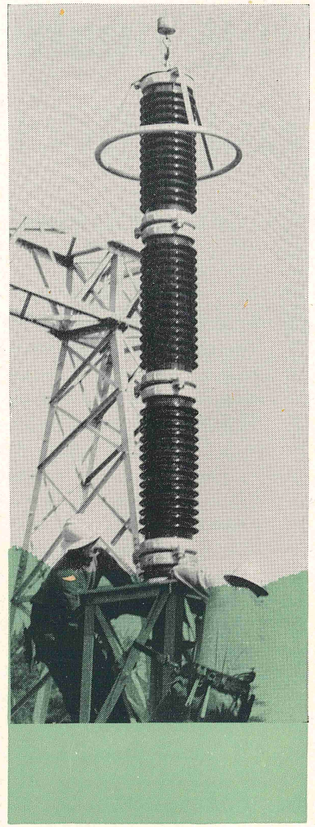




9

Men guide the base into position on station steel.

8 The arrester, ready for final installation, leaves the ground.



10

Base mounting bolts are installed.

11 Hoist hook and lifting clevis are removed from arrester cap. This man was back on the ground in seven minutes' elapsed total time from the start of work shown in photo No. 1.

simplest type of base structure is used. This is built during the erection of station steelwork and requires no special construction equipment or skills.

The cap which is supplied with all Thorex arresters of this type has an integral suspension lug and generous lifting strength for those cases where an arrester may be permanently suspended. Therefore, all the requirements for this method of construction are present in the arrester as regularly supplied.

In addition to eliminating the lifting of every unit into place, along with repeated handling of hoist cables, assembly on the ground completely simplifies the process of flange bolting.

Accompanying this report is a step-by-step series of photographs taken during the erection of the second pole of this 230-kv Thorex arrester. These will illustrate the exact procedure which cuts installation time to a minimum.

These arresters, rated at 182 kv, provide surge protection for two 75 mva, 220/66 kv transformers which employ 825 kv BIL on the high voltage windings.

Pending bushing standard will have a material effect on capital investments

With a background of 40 years in the bushing business, O-B speaks its mind on a subject close to its heart..

Joint committees representing the user-group of power companies and the manufacturers of apparatus are rapidly nearing agreement on a national bushing standard to cover all popular voltages. Presently an ASA Standard exists for the range of 23 to 69 kv, inclusive. Standardization into the higher voltages now appears to be imminent. Major questions have been resolved. There remain only some minor details yet to be settled before a final standard is established.

Having been a principal bushing manufacturer for nearly 40 years, we at O-B have seen the problems of non-standardization at close range. Our experience is the accumulation of background gained from hundreds - perhaps thousands - of bushing users over a generation.

Prior to standards for station apparatus and in turn, bushings, it was almost an accident that a bushing from one piece of equipment would fit another! This created a serious problem in the matter of spare units for emergency replacement. A power company was forced either to maintain an enormous inactive inventory investment or to seek quick delivery on a special item of manufacture.

In the latter case, ordinarily only the original bushing producer was capable of making the replacement. This practically eliminated any freedom to negotiate competitive prices or to obtain better shipping promises.

Under the best of conditions, such shipments were disappointing since manufacture of a special bushing could not start until the order was received and its details analyzed. Then, particularly if special porcelain parts were involved, long delays were simply unavoidable.

For many years the Ohio Brass Company has not only felt - but said - that such conditions were deplorable.

Under national industry standards, bushing variety will be vastly simplified. All bushings of similar characteristics will be fully interchangeable, not only between different pieces of apparatus but even between different manufacturers. If a single bushing needs to be purchased, normal buying conditions will prevail. Delivery is likely to be much less of a factor. Repetitive manufacture of standard items means that the bushing in question will be in current production and, perhaps, an "off-the-shelf" shipment.

Standardization has this further advantage; because variety will be very limited and all bushings interchangeable, the necessary inventory of spare replacement units will be small. It will be economically feasible to maintain a full emergency supply in local stock. At a given voltage this might easily amount to only two bushings; one for transformers and one for circuit breakers.

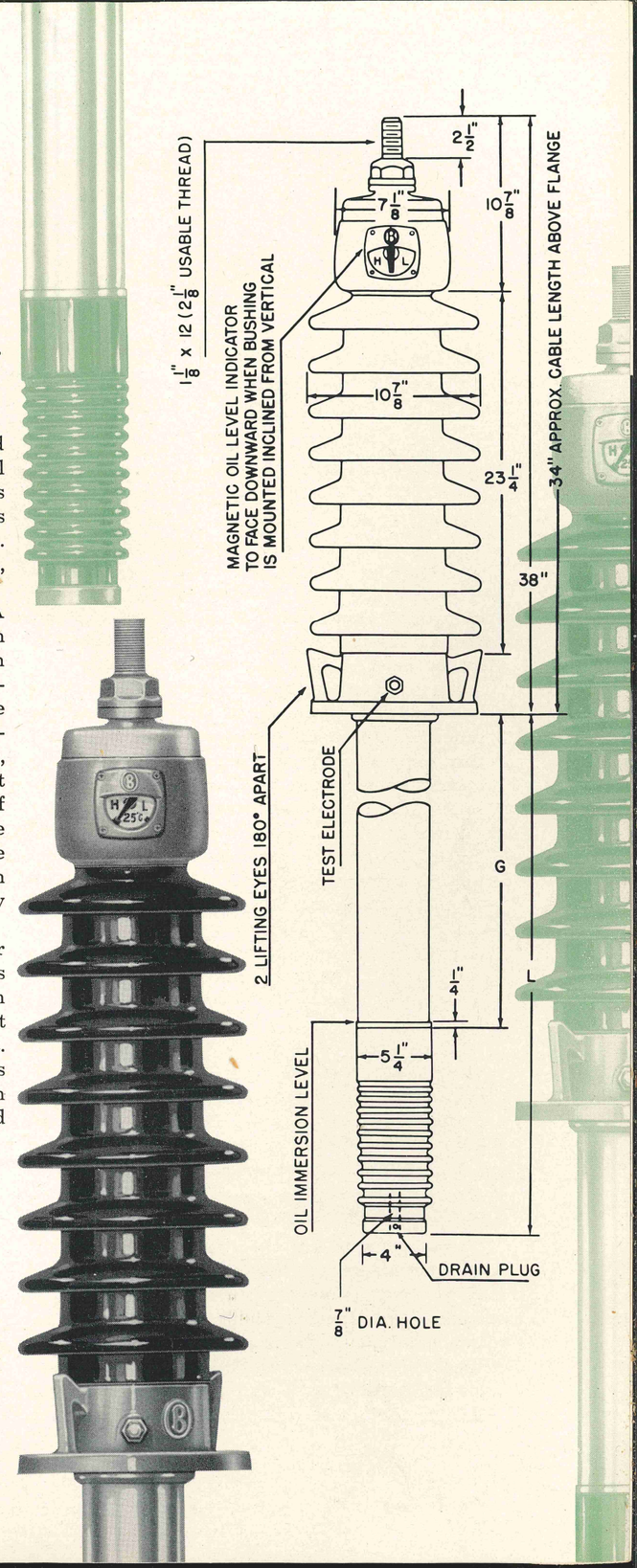
Many people have wondered what relief, if any, the standard will provide for existing conditions. Naturally, thousands of non-standard transformers and circuit breakers, with their thousands of different bushings, are going to be in service for at least the next 20 or 30 years. Does this tend to perpetuate the problem of spare bushing stocks?

In most cases, no! Fortunately the trend of all new designs is in the direction of reduced cardinal dimensions. Standard bushings will fit the mounting holes in older apparatus usually with room to spare. Naturally some adaptations will be necessary, but these will consist of relatively inexpensive fabricated metal parts that can either be stocked or obtained locally on short notice. This procedure will require a survey of existing apparatus in the light of new standards, but the time and effort will be well justified by a diminishing major capital investment, plus a radically improved quality of service protection. It has seldom been possible, in the past, to have a spare bushing stock represent 100 per cent protection of all apparatus. A fraction of such a stock, however, in the form of new standard bushings and a supply of simple adapters will offer full protection for the first time. And, as the older apparatus goes out of service, it does not automatically obsolete these spare bushings. Being standardized and fully interchangeable, obsolescence is not a factor.

These are some of the advantages of an ASA bushing standard throughout all voltages which is now in its final stages of being worked out in committee. We are members of several committees involved and know only too well the difficulties surrounding final and complete approval. The work will be expedited, however, and the day of establishment will be brought closer, when users fully appreciate the value of a standard and take a positive stand on the matter of getting it accomplished. And then the last step, and most important, is the promotion of standards, once established, through company purchasing policies.

In the final analysis the dollar of the power company buys the bushing, and how that dollar is spent will "call the tune" for the whole program of standardization. The manufacturer cannot force such a program down the buyer's throat. But if the buyer wants a standard bushing, he is now at the threshold of having it and, in our own opinion, it is both tremendously worthwhile and long over-due.

CATALOG NUMBER	GROUND SLEEVE LENGTH	TOTAL LENGTH BELOW FLANGE
	G	L
45413	16 3/4"	30 1/2"
45414	21 1/4"	35"
45415	27 1/4"	41"



What about hidden values in O-B insulators?

You buy a suspension insulator for $3.40; a low voltage pintype for $0.43; or bushings worth $5430 each with a transformer.

You buy a certain shape. You buy on the basis of electrical and mechanical values. You buy the fact that the porcelain has passed certain standard tests required for the piece purchased.

We would also like to consider some of the things you buy that you may not realize you are buying. You pay for them, of course, since they must inevitably find their way into the price. But they're real bargains nevertheless.

A good example is the series of controls placed on the raw materials that go into the porcelain mix. The mix is standard for the entire plant operation. We don't mix one batch for pintypes and another batch for bushing shells.

Before any ingredient -- feldspar, flint or clay -- goes into the mix we must first of all know its exact characteristics.

One handful of China clay, feldspar or flint looks much like another handful. Carloads also look alike.

But we know that Mother Nature wasn't too particular in making some of these materials. There are many variations, variations that could affect the composition of the finished porcelain, and consequently, could affect the mechanical and electrical characteristics of the insulators that go on your lines.

The business of building uniform quality into O-B insulators starts the moment a carload of raw material pulls on to our railway siding. We learn the moisture content, particle size, mineral structure, silicon content, dry and fired shrinkage values, dry and fired modulus of rupture, loss in weight during firing, pH factor, and other key facts.

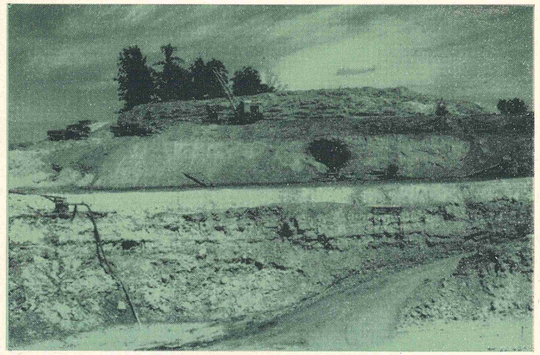
Consider grain size, for example. A few microns more or less may not seem important. But we know grain size affects the percentage of homogeneity achieved during firing. The more homogeneous the porcelain the greater the mechanical and electrical strength of the insulator in which it's used.

The percentage of water in the raw materials and how it's supplemented during manufacture are key factors. We prefer to receive clay that has 12 to 15 per cent moisture, although it would appear we're paying needless shipping charges on the water. The right amount of moisture increases the plasticity of the clay, making it easier to form and increasing efficiency of manufacture.

The pH factor -- the measure of the acidity or alkalinity -- in clay would seem to be a matter only for the concern of gardeners and farmers. But it's important to a porcelain manufacturer, too. Clay that is too acid won't flow properly and hold its shape after forming. By checking the clay before it goes into the mix, we know whether to add salts to raise its alkaline value.

And so it goes with each of the dozen or more checks that we perform on raw materials for porcelain. Each check has an important purpose. Although the finished product seems a long way off, there's a definite correlation between rigid control of raw materials and the high quality of the product. These controls are the hidden values that you get in every O-B insulator whether it be a small pintype or a large bushing.

(Second article in a series)

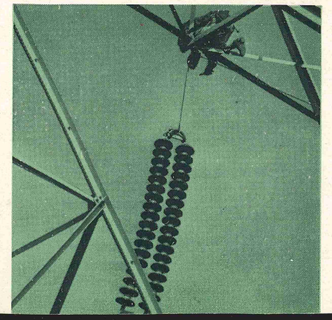


Because we know exactly what comes from here . . .

You know exactly what to expect from the insulators that you install here . . .

Selection of clay has an important part in determining the quality of the final product. Only certain types of clay are suitable for O-B insulators. Mines supplying O-B have certain areas of top quality clay staked for our exclusive use.

Grains of clay, feldspar and flint are the "building blocks" with which porcelain insulators are made. Grain size affects homogeneity; homogeneity affects mechanical and electrical characteristics; so we start by checking the grain size of our ingredients.



Interested in Surface Leakage?

Technical paper enclosed with this issue of Hi-Tension News gives complete review

"Present day insulator designs perform well in the great majority of contamination conditions. However, the reader should recognize that no universal solution is available for the variety of contamination exposures which exist. Certain countermeasures are partially effective in some applications and the individual user must determine which schemes offer the most promise and represent the best economic compromise."

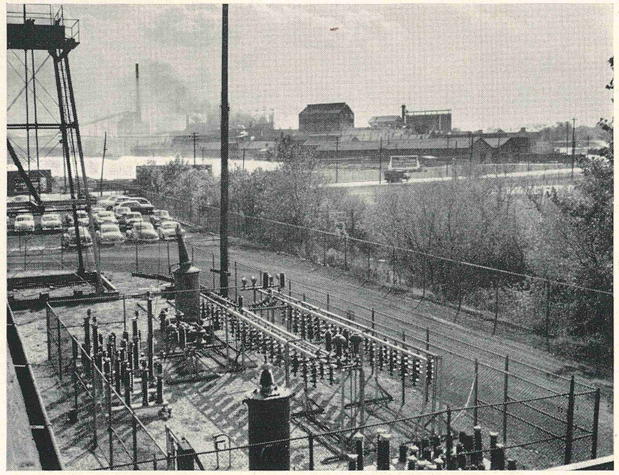
So reads the first paragraph of the conclusions reached in a paper, "A Review of the Surface Leakage Problem," presented by O-B Development Engineer A. D. Lantz, Jr., at the Ninth Annual Power Distribution Conference, conducted by the Department of Electrical Engineering at the University of Texas in October.

The paper discusses various solutions or partial solutions to leakage problems, among them being over-insulation, changes in insulator shapes, use of protective coatings, and cleaning methods.

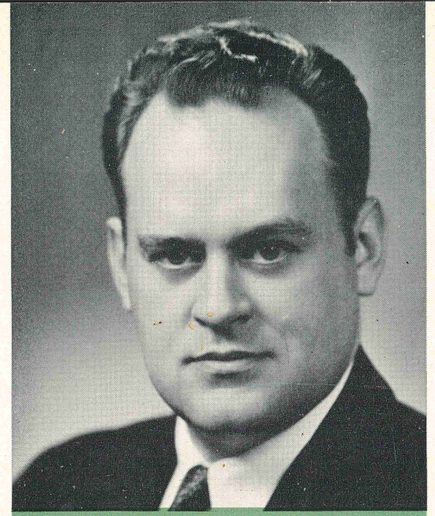
Described are the many tests that have been performed and are being continued by Ohio Brass, including an outdoor test installation "favored" by a highly contaminated atmosphere. Dozens of shapes and sizes of insulators, both O-B and competitive designs, have been placed on the test racks. Each test specimen is isolated from ground and currents flowing over it are carried by insulated leads in conduit into the laboratory building where surges are recorded.

Because the paper is of general interest to the electric power industry and of special interest to those with surface leakage problems, we have included a copy with this issue of HI-TENSION NEWS. We'll be glad to supply additional copies on request.

69-kv Multipart insulator after about three years of exposure near a cement plant. A prior application of silicone wax, as discussed in the paper on surface leakage, would have made removal of these deposits much easier.

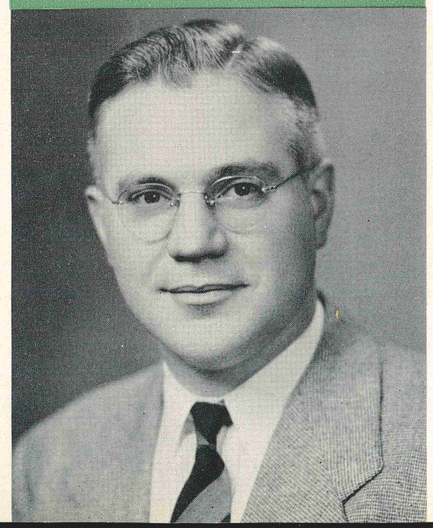


General view of the outdoor test location where Ohio Brass collects much of its data on surface leakage.



P. M. ROSS

H. E. SHOEMAKER



W. B. JOHNSON

Two new O-B divisions headed by Ross, Shoemaker

Johnson to manage Foreign Trade Department

Two new divisions have been formed in the Ohio Brass Power Utilities Department as part of a program to expand service to customers.

W. H. Burleson, manager of the department, has announced that P. M. Ross has been appointed head of the Equipment Division and that H. E Shoemaker is the new manager of the Transmission and Distribution Division.

Mr. Shoemaker's new assignment represents a return to the Power Utilities Department after 20 years service with the Foreign Trade Department, the last seven of which were spent as Manager. He joined Ohio Brass in 1934 following his graduation from Iowa State College as an engineer. He is a member of AIEE, the National Foreign Trade Council and NEMA.

Mr. Ross has been a member of the Power Utilities Department since 1948 and Assistant Manager for the past three years. He joined O-B in 1934 as a staff engineer and later served as manager of the company's Barberton high voltage laboratory. Mr. Ross holds an engineering degree from Purdue University, and is a member of AIEE and NEMA.

Taking Mr. Shoemaker's position as Manager of the Foreign Trade Department will be W. B. Johnson who has served in that department since 1942.

After joining Ohio Brass in 1936 as a test engineer, Brad Johnson became a transportation engineer two years later. He is an electrical engeering graduate of Ohio State University and a member of AIEE.

the best LIGHTNING ARRESTER at half the price

Extreme speed and simplicity of Thorex construction make installation costs almost negligible

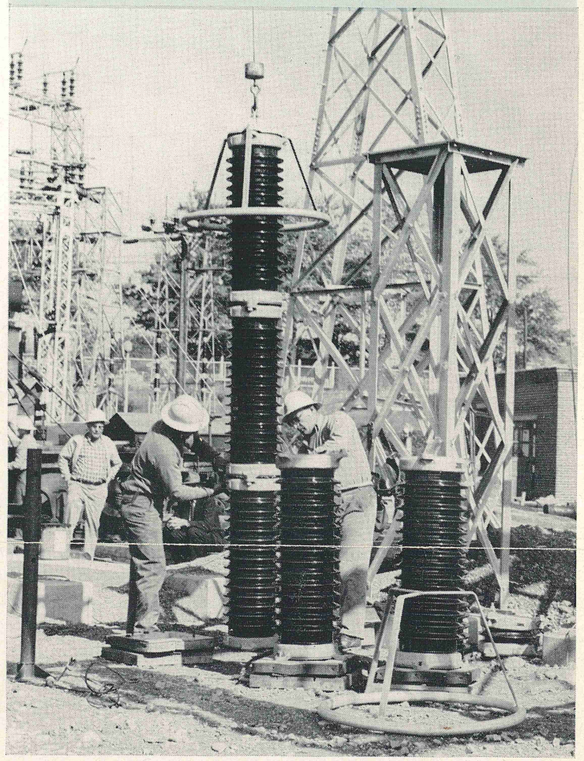
This 230-kv Thorex lightning arrester pole was built, complete, by three men in only seven minutes. **Total** installation labor was only one-third man-hour!

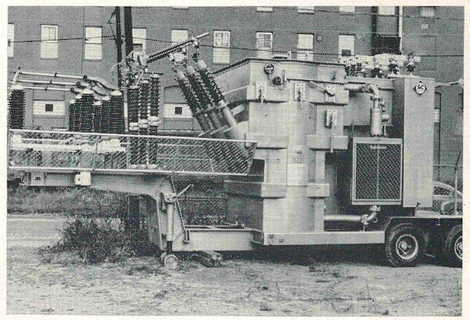
Simplified Thorex design makes this possible. Few, large units minimize stacking connections. Self-supporting design eliminates all external bracing, all special structures, all mechanical or insulated auxiliary supports.

But this is just part of the story. The finest combination of protective characteristics you can get will be found in the Thorex. And, since installation is just as much a factor in arrester cost as the manufacturer's invoice, this high grade of protection is yours at remarkably low price -- perhaps half what you might otherwise pay!

Specify Thorex for your major equipment protection -- the best arrester investment you can make today.

All assembly was done on the ground. The arrester was built "from the top down." Hoist cable was attached to the integral lifting eye on the top unit. This was then raised and connected to the second unit. The pair was then positioned on the third unit, as the picture shows. This convenience was a major factor in time-saving.

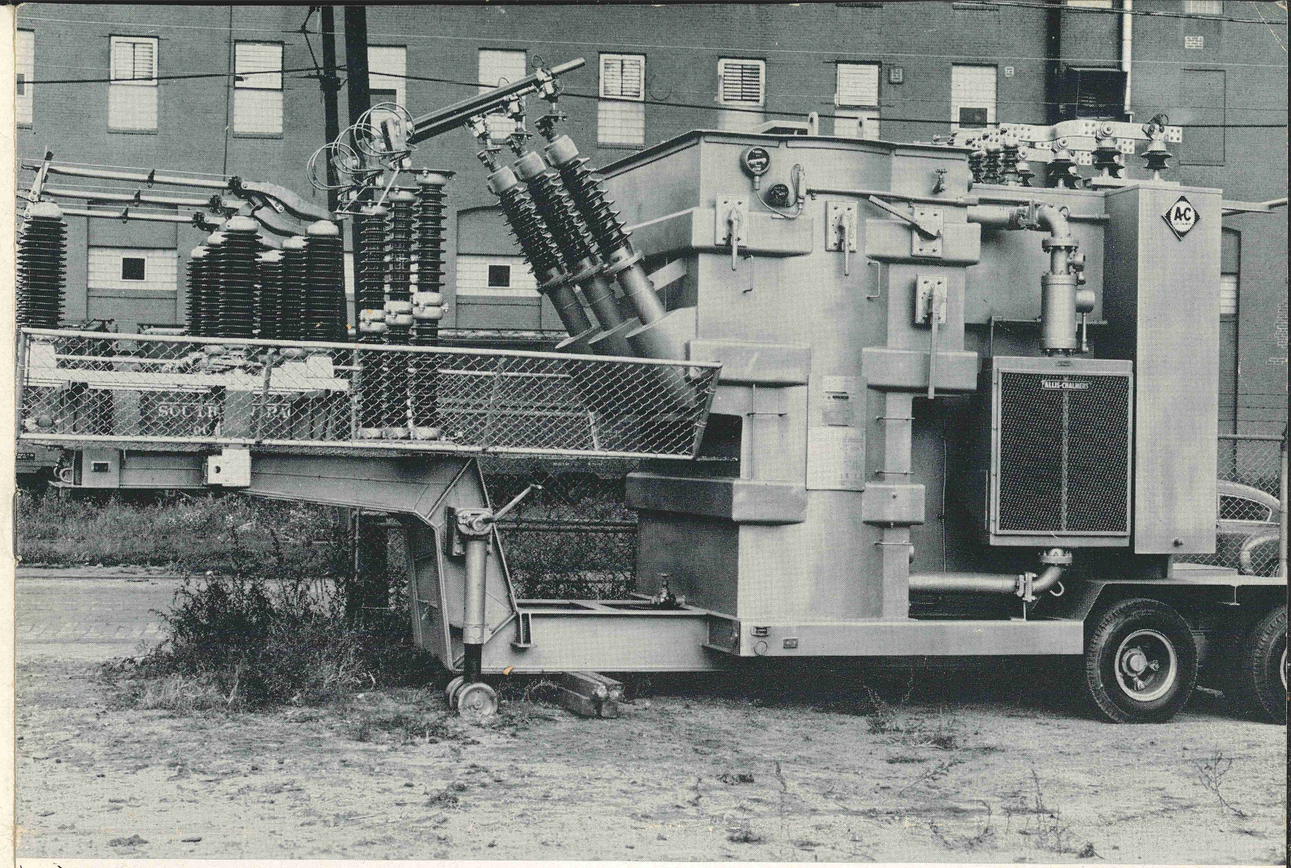




THE COVER STORY

New 7,500-kva, 69-kv mobile substation recently built by the Pittsburgh Works of Allis-Chalmers. We take special pride in this piece of apparatus, since it contains Thorex GP-73 lightning arresters and our new GK-30 condenser type transformer bushings.

6020-H Printed in U. S. A.



hi-tension news

Vol. 26 - No. 1 Published by Ohio Brass Company • Mansfield • Ohio

JANUARY 1957

throwing a new light on

RAW MATERIALS

flame photometer provides quick method of analyzing soluble alkalies in clay, feldspar

Whereas the X-ray equipment excites electrons to get a radiation pattern, the flame photometer burns them. The color of the flame and intensity tell what unknown alkalies are present in raw materials.

What have we got to work with?

That's a basic problem in manufacturing insulators. In the answer lies much of the secret of long insulator life on your lines. We need complete control of raw materials in that we must know exactly what we're working with.

Unless we know, much of the care taken in manufacture and inspection would be wasted.

That's why there's an elaborate system for determining moisture content, particle size, mineral structure, chemical composition, silica content, dry and fired shrinkage values, dry and fired modulus of rupture, loss in weight during firing, pH factor and many other key facts about raw materials.

Not only do we get this information on all incoming materials, we then test the accuracy of our findings by actually using the materials in a pilot plant operation. Here, on a small scale, we go through the production operations that are carried on in the factory. In the pilot plant we can afford mistakes we can't afford in production.

We use a wide variety of instruments and techniques in determining the exact composition of each load of raw materials.

Newest in our battery of instruments is the flame photometer, while the instrument that probably did more than any other to take guesswork out of analyzing the crystal structure of raw clay is the Geiger Counter X-Ray Diffractometer.

Diffractometer operation has been discussed in detail in previous issues of Hi-Tension News (April, 1954). We chose X-ray diffraction as our basic method of determining minerals present in clay over several other methods. Our study of comparable methods showed, for example, that X-ray diffraction gives more positive identification of mineral crystals than does differential thermal analysis.

Another X-ray machine that helps in analyzing materials is the X-ray spectograph. Whereas the diffraction unit determines which crystalline minerals are present, the spectograph indicates the actual elements in the raw materials.

The newest weapon we have in our battle to identify the elements is the flame photometer. It's a quick way to determine the amount of soluble alkalies present, especially in clay and feldspar.

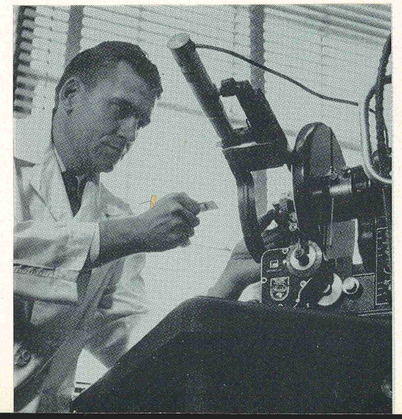
The soluble alkalies and alkaline earth metals in which we are interested are sodium, lithium, potassium, calcium, barium and strontium. Sodium and lithium can not be analyzed with the present X-ray spectograph. Calcium and potassium may be determined by the spectograph in small percentages. But the flame photometer is by far the simplest and most rapid tool for finding out what we need to know about the alkalies.

Even a small amount of an alkali (below one per cent) can affect pH factor and viscosity of slip and glaze. It can affect the preparation, workability, and fusion range of the clay body . . . all of which affect the quality of the finished insulator

Operation of the flame photometer is fairly simple. Liquid samples are introduced and atomized by a stream of compressed air which carries the sample into the base of the burner. The fine particles are excited by the burner, giving spectral emissions. The light passes through prisms which disperse it into a spectrum. Light of various wave lengths can be filtered out of the spectrum and measured by phototube. An accurate determination of the element and the amount can be made by comparing the measurements of the sample with a standard.

In simpler terms, here's what happens. We put an unknown solution in the photometer. The flame burns in color. We measure the intensity and wave length of the color and learn what the unknown element is.

The flame literally throws a light on the unknown, and production can be regulated to compensate for the type and quantities of soluble alkalies present in the raw materials.



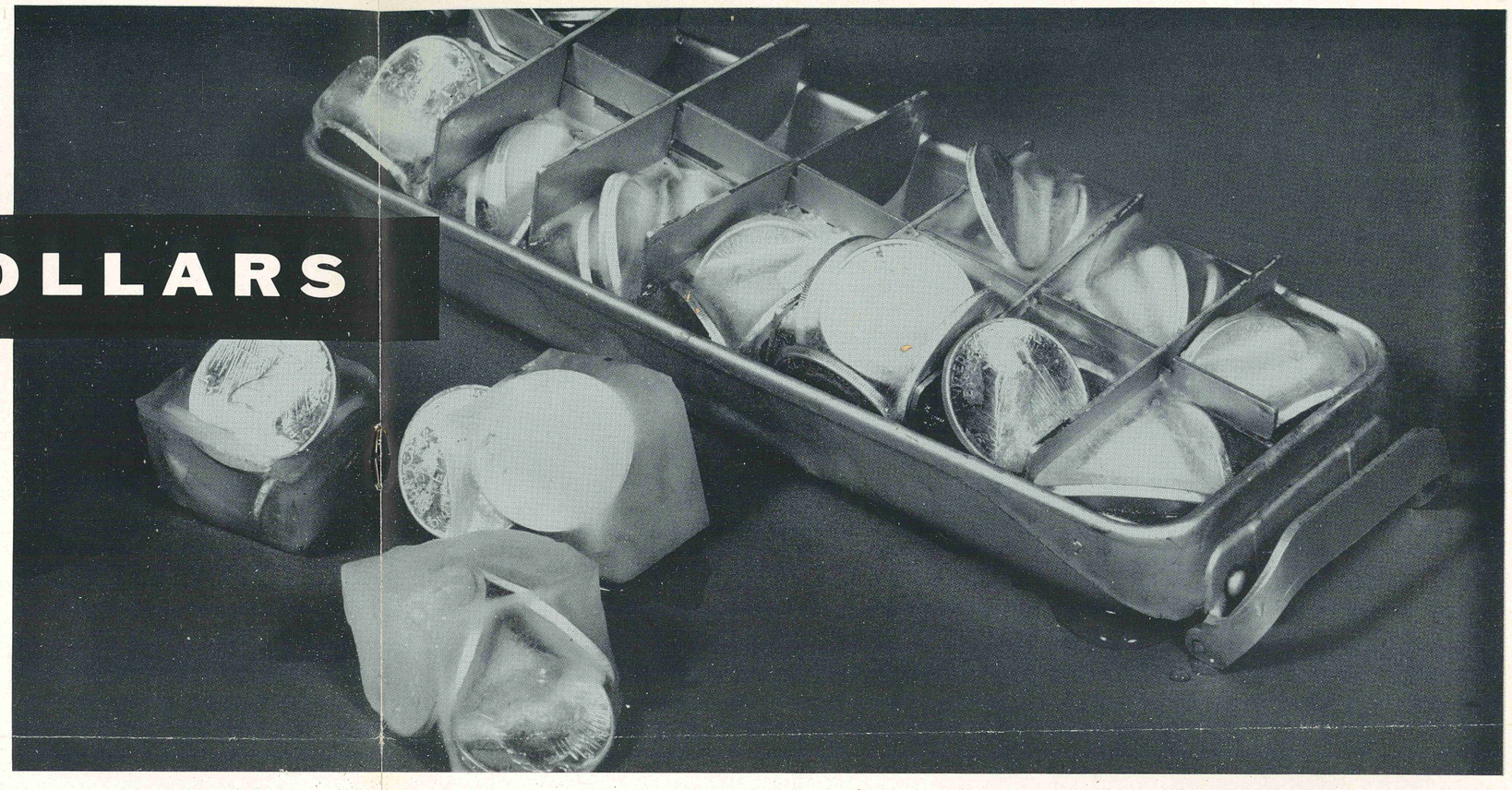
For positive identification of crystalline minerals present in clay and other raw materials for porcelain, we depend on the X-ray diffractometer. The diffractometer records the "fingerprints" of each crystal on a chart. Comparison with fingerprints of known minerals provides quick, positive identification.

how many

FROZEN DOLLARS

must you tie up in spare bushings?

ASA industry standards promise a welcome remedy for this inactive capital investment



Quite recently we carried in our files over 1,000 active drawings against which bushing orders could be entered. These usually involved only minor differences in various dimensions or terminal constructions. Unless by sheer accident, none of these bushings were interchangeable. Add to this situation the fact that we are **only one** bushing manufacturer. It is not exaggeration to brand this as "chaos."

To continue, if a replacement was required, it had to be produced by the original manufacturer in accordance with some specific design. When such a replacement order was received by the supplier, it often involved "starting from scratch" in the manufacturing process. When this included the production of special porcelain parts with their long drying times and firing cycles, delays were simply unavoidable.

For safety, the electric power industry did the obvious thing. All important apparatus was protected by spare bushings carried in quickly-available local stocks. This established very sizeable inventories, inactive for the most part, and representing considerable frozen capital. In other words, it was mighty expensive insurance!

These are some -- and by no means all -- of the evils of non-standard bushings. For many years the Ohio Brass Company has deplored the situation. We have spoken out against it. We even tried a degree of standardization within our own line, only to end up with that many more bushings.

Now, there is very great promise of an end to this unsound condition. Presently the ASA industry standard is in force for the 23-69-kv range. Higher voltages are on the threshold of similar action. What effect will this standardization have?

These new ASA standard bushings are completely interchangeable. One spare bushing, instead of protecting just one piece of apparatus, might easily protect many pieces of such equipment of that voltage over an entire system. New apparatus purchases may not require new spare bushings. Retirement of one piece of apparatus will not automatically obsolete the stand-by bushing. In short, spare bushing inventories can go from an inactive "very many" to a useful "very few."

Standard bushings are a regular production item. If a replacement must be ordered, there is a great likelihood of its being in stock, and no chance of the aggravations and penalties that once accompanied custom-built designs.

This, of course, is looking rather far ahead. Thousands of pieces of apparatus using non-standard bushings will be running for the next 20 to 30 years. Does this tend to perpetuate the past? Fortunately, in most cases, no. Trends, under the standard, are toward radically reduced diameters. A modern bushing will fit older apparatus usually with much room to spare. Some simple adaptation will be needed, but this is neither complex nor costly. Therefore, standard bushings can have an immediate good effect on inventories, and one that will grow as the years go on.

In telling this story to some people, we have had the answer: "Well, so what, you've got it and I'm glad, but why all this promotion of standards?".

The fact is, we haven't got it! All we have is the means toward an end. Just like you, we at O-B enjoy eating, and if you order non-standard bushings, we will manufacture them. If this happens, however, a great opportunity will have gone by the boards. The ASA standard will live and flourish in proportion to the support it gets from the electric power industry. The power company whose dollars buy the bushings can spend the dollars at it sees fit. Therefore, the support and success of standards depends, ultimately, on the purchasing policies of the individual electric utility.

monograph #14

OIL PUNCTURE TEST

Comparison of results from the oil puncture test with historical values is one measure of quality and expected service performance.

Since we know each insulator's ancestry, this test tells a lot . . .

An insulator in service will never encounter the conditions imposed upon it by the Oil Puncture Test - one of the series of design tests carried out by O-B.

We don't expect it to perform in a bath of oil. Neither will it encounter 60-cycle voltage high enough to puncture the porcelain. That's what happens in the Oil Puncture Test.

Yet out of this seemingly unrealistic test come results that provide a good check on quality control. These results are significant because we know the ancestry of the insulator being tested. We know how those ancestors fared on the Oil Puncture Test. We know how the contemporaries of those ancestors served when installed. By correlating this information, we know what can be expected of the insulators currently being produced.

The test is described in ASA standards (pgh. 4.7, ASA 29.1 -- 1944) and on page 141 of the No. 28 O-B catalog.

In the test, the assembled insulator is inverted and immersed in oil having sufficient dielectric strength to prevent external flashover before puncture occurs. The oil must be at least six inches deep over all parts of the insulator.

Voltage is then applied between the electrodes (cap and pin of a suspension unit, or electrodes provided especially for the test as is true with a pintype, for example) at the rate of 10,000 volts every 15 seconds until the insulator punctures.

Initial applied voltage may be raised quickly to the rated dry flashover voltage of the insulator. When several insulators are tested, the variation is analyzed by statistical methods.

What does this test tell us? Basically, it's a check on the insulator's value as an electrical barrier. It's a quality control measure. It assures the buyer that a given type of insulator has as good or better insulation value than previous insulators of the same type. It's a check on the vital electrical characteristics of the insulator besides being a check on manufacturing methods.

Any appreciable change in the puncture voltage immediately starts a check of the complete manufacturing procedure, to find the reason for the change. The same procedure is followed if results in any of the other design tests deviate from the normal pattern. That's how we stay in control of the manufacturing process.

from: the Purchasing Agent's Notebook

subject: Universal Strain Clamps

Simplifies ordering too!

The O-B Universal Clamp is used primarily for deadending distribution conductor. It is furnished in sizes that will accommodate conductors from .125 to .55 inches in diameter. A dual keeper-piece, which is reversible, enables an individual clamp to accommodate a wide range of conductor sizes. Because of the Universal's versatility, clamp stocks can be held at very economical levels.

doesn't increase their purchase price but does increase their value —

Ohio Brass manufactures Universal Clamps in its own foundry where they are carefully checked to assure uniform quality -- they're made to fit other O-B hardware or insulators. Advanced methods of quality control testing and 100 per cent inspection procedures ASSURE DEPENDABILITY and SUPERIOR PERFORMANCE.

Although 90 per cent of ultimate cable strength is developed by the O-B Universal Strain Clamp, it does not shorten conductor life by crushing the strands. The Universal Clamp develops this high holding power because part of the strain is relieved by wrapping the conductor around a large radius just ahead of the clamping jaw. This snubbing action shoulders much of the tension before it reaches the clamping point.

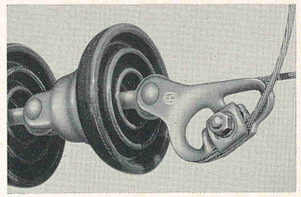
no splicing reduces installation time

There is no need to cut the conductor at each deadend point with the Universal Strain Clamp. All that is required is a simple loop to form a continuous jumper.

In the jumper deadend, vibration can't cause chafing or weakening of strands where the looped conductor crosses itself. The clamping jaw is shaped to provide adequate offset and clearance of the conductor at the crossing point. This easy-to-install, easy-to-maintain cable attachment for distribution deadend assemblies has become standard with hundreds of companies.

efficiency

Line crews prefer O-B Universal Clamps because they are so easy to install, even while wearing rubber gloves, and they can be easily hooded for hot-line work. Fewer dropped parts and simple finger operations are the reasons for the linemen's choice.



As with other O-B distribution equipment, these clamps are designed by men who know purchasing problems. They have been subjected to the toughest test known - years of actual service under all kinds of conditions.

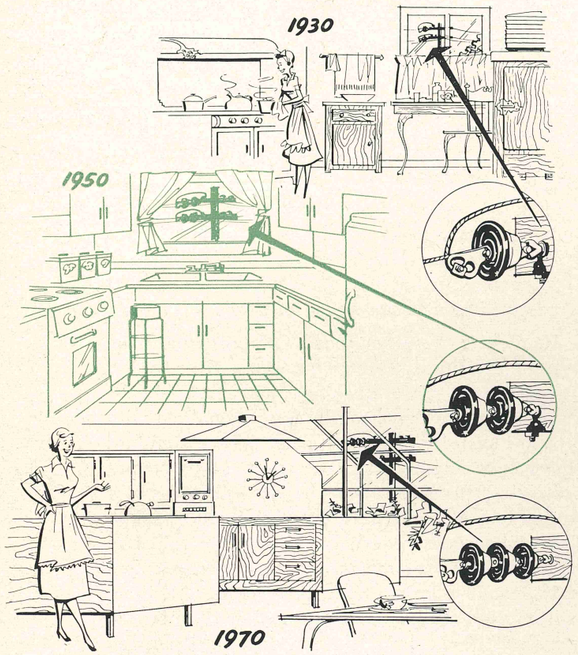
Graybar means convenient, fast delivery.

Specify O-B Universals when ordering clamps. They're available at the nearby Graybar distributor.

NATIONAL ELECTRICAL Week

FEB. 10-16, 1957

Points To Needed Reserve Capacity NOW



Every bit as big as the imagination and crackling with enthusiasm -- that's the future of electrical power and the programs being used to promote it. This National Electrical Week, 1957, provides an opportunity for analyzing how we're going to meet the demands of 1970.

When the tremendous impact of manufacturers, home builders, contractors, architects, electrical distributors, dealers, realtors, and even lending institutions upon the consuming public is considered, there's good reason to be optimistic. One specific goal of the LIVE BETTER . . . ELECTRICALLY program, for example, is to raise the average consumption of electricity from 2500 kilowatt hours to 4500 kilowatt hours per family by 1960. Will you be ready for this increased load?

Aside from living better . . . electrically, the economy of the United States has every indication of surging ahead. Population is increasing at the rate of 2 million a year; disposable income as well as the formation of new families is also on the rise. Employment should reach 70 million by 1960, 75 million by 1965. The economic climate alone indicates greater, much greater consumption of electrical power in the next decade.

ELECTRICAL WORLD magazine, in its **Electric Utility Industry Market Forecast 1956-1970,** predicts that residential sales of electric power will increase by 400 per cent by 1970. Rural sales, now at 20 billion kilowatt hours, will expand about 175 per cent by 1970.

ELECTRICAL WORLD goes on to say that higher primary voltage will increasingly be used to get system capacity, particularly for new areas and for trimming off fringes of overloaded lower-voltage systems. Higher voltage gives each feeder the ability to serve more customers. It also permits locating substations farther from the customers they serve. Higher voltage reduces the number of substations, and the difficulties encountered in finding sites for them. For additional savings, these sites can often be powered directly from open wire instead of cable subtransmission.

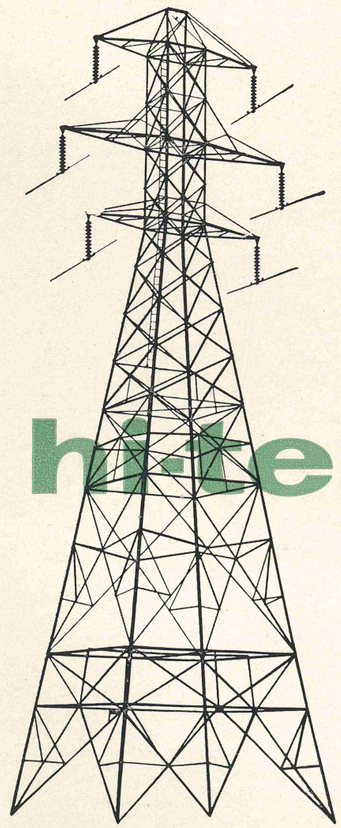
With these higher voltages, of course, you'll need more insulation. Now is the time to build deadends with an extra unit to insure the line's easy conversion to higher voltage. Ohio Brass has been playing this tune for some time now; here, during National Electrical Week, we have another strong reason for repeating it.

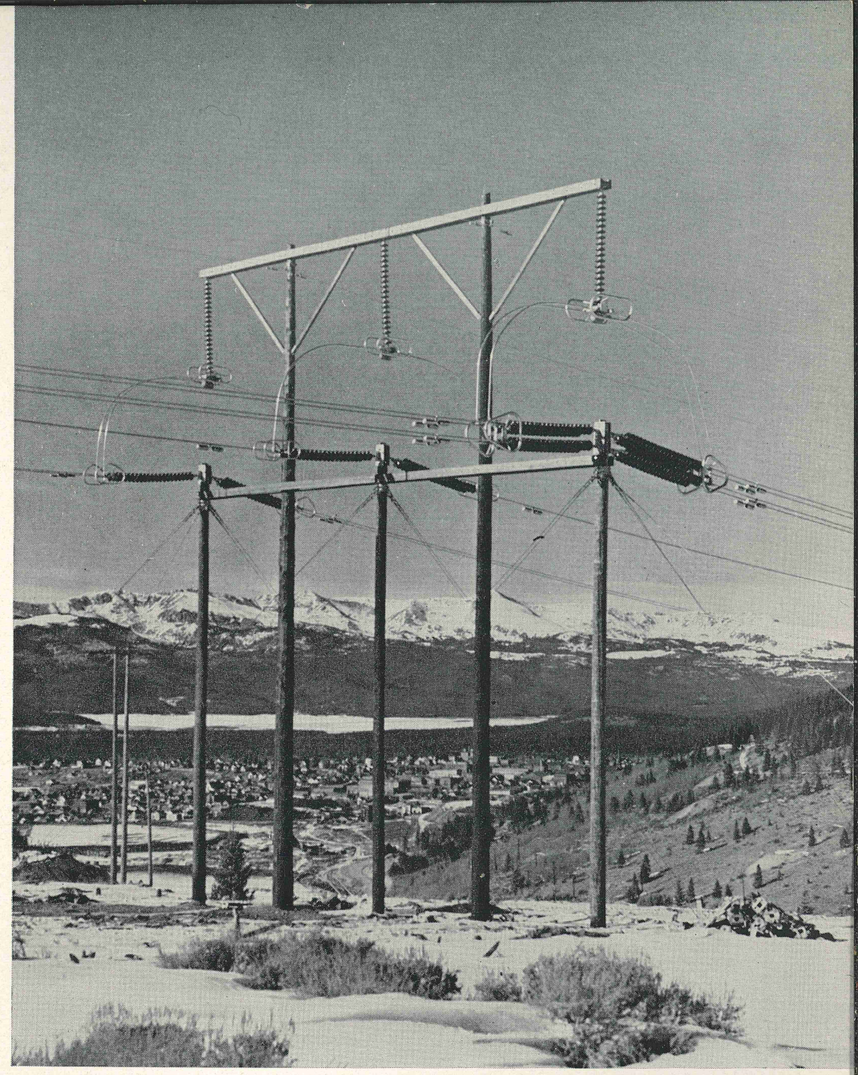
As long as the lineman is installing or replacing a deadend, he might as well put in three six-inch O-B Suspension Insulators instead of two. This will insure a reserve capacity for many years to come - provided also that the conductor is large enough. Such measures will help insure your system's readiness for the future.

Each year, National Electrical Week will point out a new and expanded market for power. Your distribution lines should be built for these loads today.

Remember that Graybar is ready to afford prompt delivery and quick service so that you can begin your program for adequate reserve insulation today.

6021-H Printed in U. S. A.





hi-tension news

Volume 26 ● No. 2 Published by Ohio Brass Company, Mansfield, Ohio

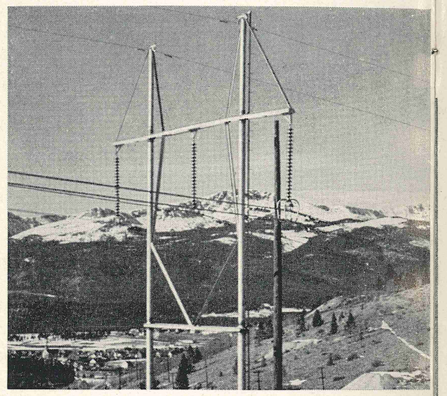
FEBRUARY 1957

progress at Leadville . . .

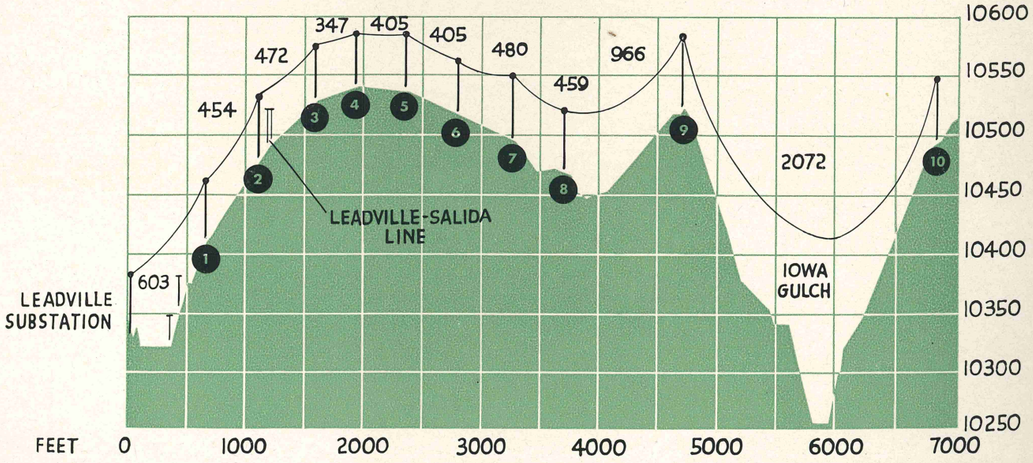
EXPERIMENTAL EHV LINES GO INTO OPERATION

Public Service of Colorado seeks answers on high voltage transmission at high altitudes

1. No. 1 structure is made of tubular steel. Mountains of the Continental Divide can be seen in the background.



2. Close-up of 500-kv substation. Besides transformer and lightning arrester, it has 330-kv motor operated switches, and cross ground wires to ground switch which grounds the line when open. Aluminum tube connections from switches to line conductors had not been installed when photograph was taken.



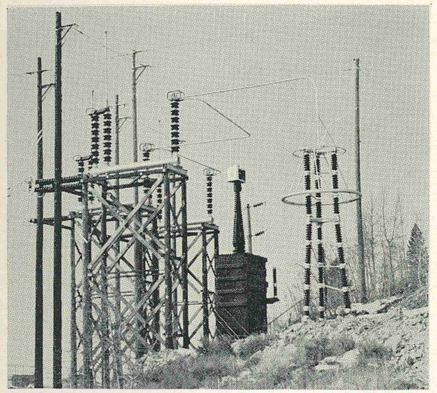
PROFILE OF LEADVILLE TEST LINE

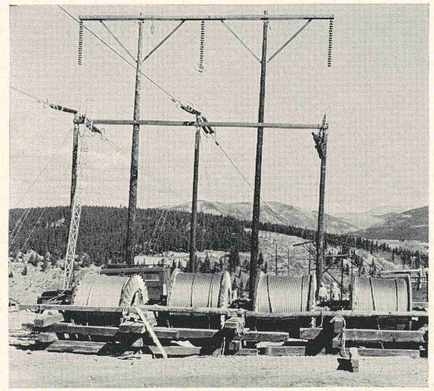
The management of Public Service Company of Colorado knew it was inevitable. Some day, only a few years away, it would be necessary to get more power for Denver's growing industrial and residential load. On the western slopes of Colorado, across the Continental Divide from Denver, were coal sources and several possible sites for generating plants. Also, the load in that area was increasing.

To tie this growing system together, more transmission lines would be required, built through and over the Rocky Mountains at altitudes varying from 5000 to 12,500 feet. Extra high voltage, at 300 kv or higher, offered an attractive method for transmitting the large blocks of power economically, especially since construction over and through the mountains would be far more expensive than over ordinary terrain.

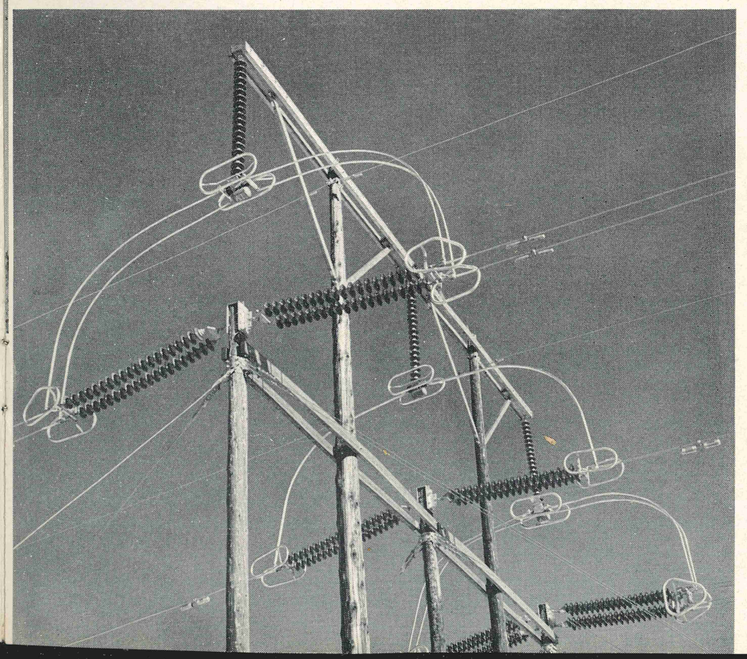
Now came the stumbling block in the path of logic being followed by Public Service Company. What is known about extra high voltage transmission at high altitudes? How does the higher altitude affect radio influence and corona characteristics of conductor and hardware? What is the minimum size of conductor that can be used? If bundled conductors were used, and they might be necessary, what are the best spacing and configuration?

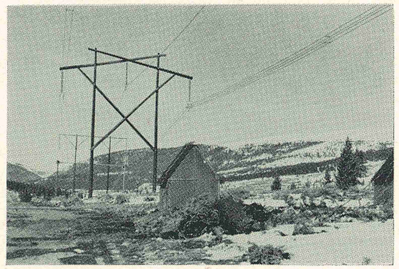
Although the Tidd project had provided many of the answers for lower altitudes, nothing defi-





3. Special five-pole deadend for radio influence choke coils. Four bundles of 1.40-inch diameter conductor are being strung on right hand phase. This structure was designed so that choke coils could be inserted in line conductors. Taller poles carry ground wires and suspension insulator strings for coils. COVER PHOTO shows structure after stringing.





5. Structure number four is modified spar construction with malleable iron fittings. Deadend number three which is shown in detail in previous photographs appears in background. Two overhead ground wires are 159,000 CM, ACSR. Small enclosures house radio influence meters.

4. Special deadend structure with insulators, control rings, choke coils, and jumper tubes in place. Radio influence choke coils were necessary to eliminate interference from secondary lines in the area.

nite was available to guide construction at 10,000 feet. What was needed was an extension of the Tidd tests, carried out in the rarified atmosphere of the Rocky Mountains. So Public Service Company decided to get its own answers, with the help of leading manufacturers of switches and transformers, conductors and accessories, insulators and hardware, wood and steel towers and wood spar-arm hardware.

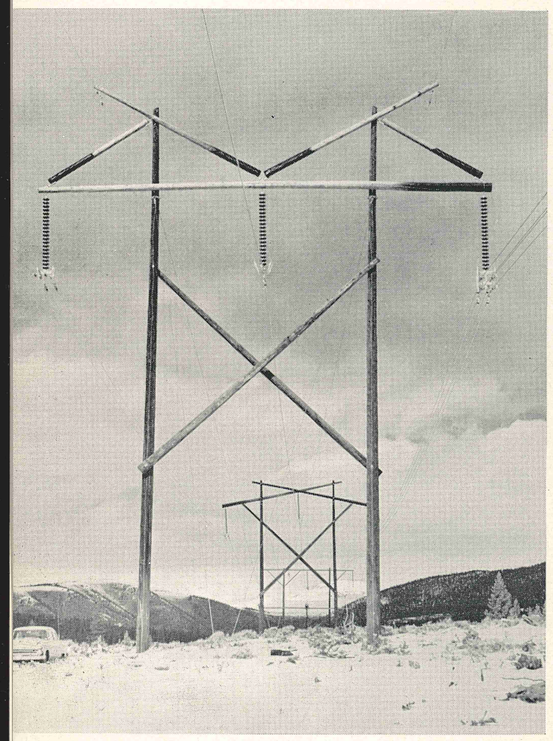
The first step toward a solution to the problem of EHV at high altitude took the form of a test line, built during the summer and fall of 1956 after almost two years of study and planning by Public Service and the cooperating manufacturers.

Site of the test line is Leadville Substation, 90 miles southwest of Denver. The location is described in one of the recent AIEE papers on the subject as "ideal to build a high voltage, high altitude transmission line for research in mechanical and electrical problems . . . " It was also the highest point in the system where 60-cycle power was available for energizing the test line.

The experimental line, designed to operate up to 500 kv, is 7000 feet long, has span lengths that vary from 347 to 2072 feet. Maximum altitude is 10,540 feet.

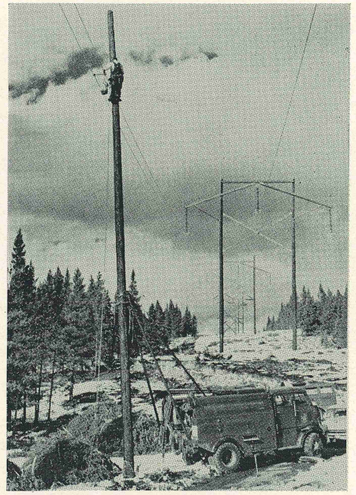
Originally, the plan was to make the test line 5000 feet long. The last span—the longest one—was added primarily as a check on mechanical

6



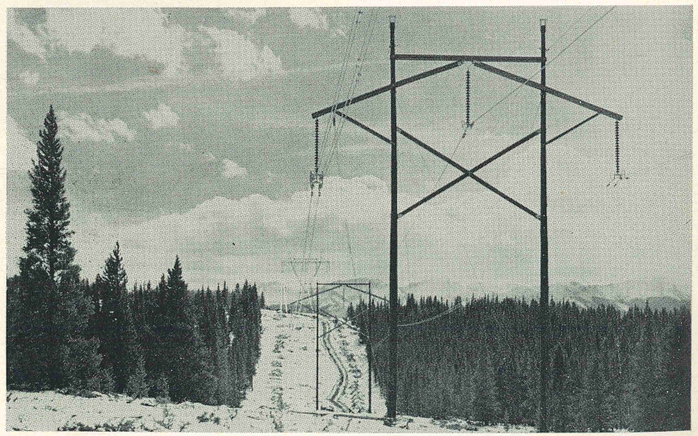
6. Structure number five is conventional spar H-frame design. Note that four-conductor bundle has been strung on right-hand phase. Tension on the bundle is 24,400 pounds at 0 degrees F., with no ice and no wind. The bottom half of the bundle was removed before heavy ice loading occurred.

7



7. Spacer being installed on two-conductor bundle phase. Two types of spacers were used. One has a helical steel spring between clamping members. The other has an aluminum tube spacer.

8. This structure uses timbers for cross arms and braces equipped with steel fittings for attachment to poles. The main poles are 85 feet long.



8

performance since the span is subjected to strong cross winds sweeping through Iowa Gulch (see profile map).

Several types of structures were used . . . a tubular steel H frame, a steel tower, wood-pole H frames with timber and spar members and two special wood pole deadends.

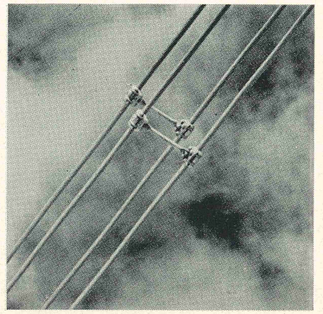
Single and bundled conductors have been installed. So that direct comparisons can be made with tests made at lower altitudes, two of the conductor sizes are the same as those already tested—single 1.65-inch diameter and two-bundle 0.92-inch diameter. The third phase is a two-conductor bundle of 1.40-inch diameter conductor, the size that theoretically should be used at the test altitude. The two conductors in the third phase were increased to four during the initial stage of the test, for calibration purposes. Conductors are spaced 16 inches apart, vertically and horizontally.

Since the test is primarily one to determine proper conductor size and spacing, control rings were designed which completely eliminated hardware as a factor in the radio interference and corona characteristics of the line. In other words, the fittings and hardware were intentionally made with radio interference and corona characteristics far superior to the conductor. To make sure this was true, extensive tests were conducted using smooth tubes as conductors—the reasoning being

9

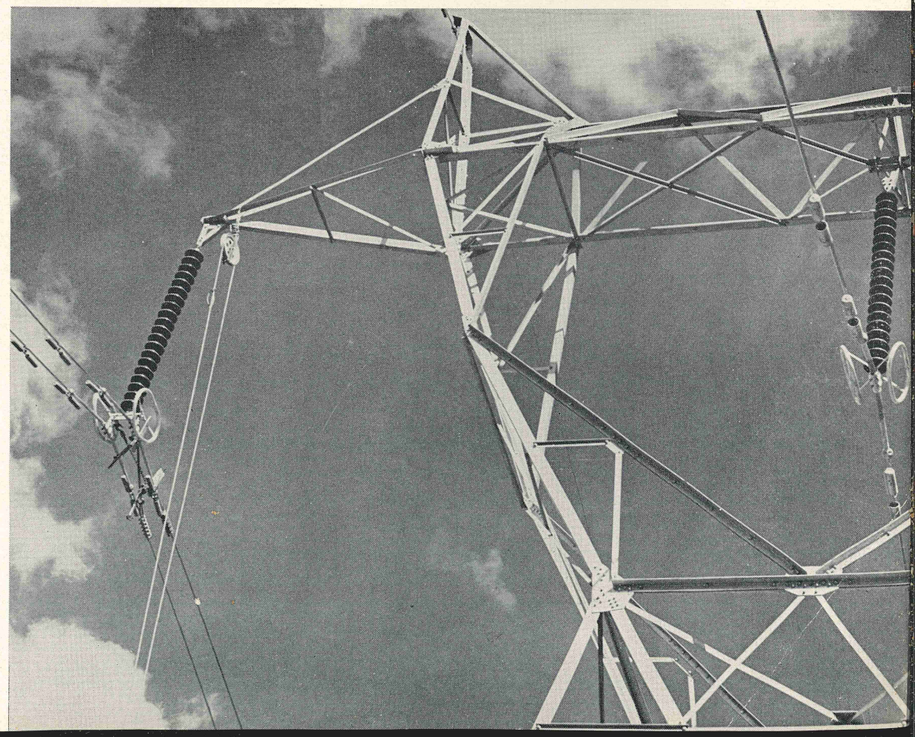
9. A helical spring spacer on the two-conductor bundle. All spacers, like the control rings and clamps, were tested before installation to make sure their critical corona voltages were equal to or better than the conductor.

10



10. Tubular type of spacers on four-conductor bundle. Spacers were artibrarily installed every 200 feet in each span.

11. Test conductors are suspended on strings of 20 5¾-inch insulators. Tapered armored rods are used at each suspension point. Single stockbridge dampers for each conductor are provided except in the longest span (shown here) where two dampers are used.



11

that if the hardware was superior to the smooth tubes it would be even more superior to stranded conductor.

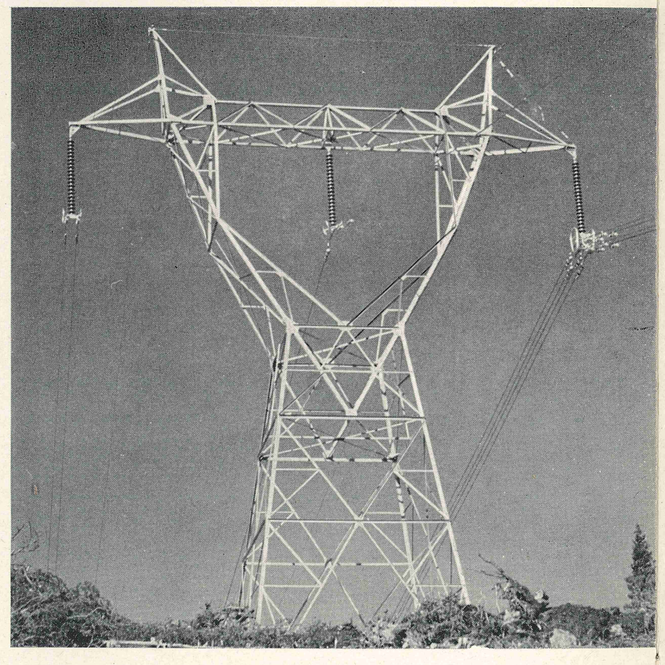
The Leadville line was energized on Nov. 19, 1956. Testing will continue for two or more years.

Cooperating with Colorado Public Service Company in the Leadville project are Westinghouse Electric Corporation, transformer, lightning arrester, switches and instruments; Aluminum Company of America, conductors and accessories; American Bridge Company, steel tower and tubular H-frame; Hughes Brothers Company, timber arms, braces and fittings; Malleable Iron Fittings Company, wood-spar-arm hardware; and Ohio Brass Company, insulators and hardware. The Public Service Company of Colorado provided all poles and spars for the line structures, the substation structure, and performed the line and substation construction.

Three technical papers on the Leadville project were presented at the AIEE 1957 Winter General meeting, January 21-25, in New York. One covered the scope of the tests and the instrumentation; a second covered conductors, towers and footings; and a third pertained to insulators and hardware.

So that you may have a complete up-to-date resume of the Leadville activity, all three AIEE technical papers on the project have been published in one booklet which is enclosed with this issue of Hi-Tension News.

12

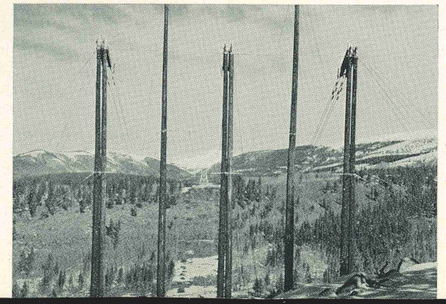


12. Structure number nine is a conventional, single-circuit, corset-type, lattice steel tower. This tower is the only suspension structure on the line designed to sustain a major longitudinal emergency loading.

13

13. Looking from the steel tower across the longest span — 2072 feet — on the Leadville test line. Two-conductor bundle on right had to be kept apart with ropes until spacers were installed since strong cross winds slapped the conductors together.

14



14. Special eight-pole dead-end structure at west end of line. Construction is now complete and line has been energized. Testing will continue for several years.

an editorial addressed to purchasing and engineering departments

HOW MUCH MONEY HAVE YOU WASTED IN THE PAST ON "SPARE" BUSHINGS?

standardized bushings offer you maximum protection, great convenience, and a radical reduction in inventory investment

ASA Standards, now applicable to bushings rated 69 kv and below, will soon be extended to include all higher voltages. Looking back on the results of some 40 years of non-standard manufacture, we sincerely believe the standard will provide the means for a substantial capital saving by power companies.

One point in connection with standards cannot be emphasized too strongly, however. Standardization is not an automatic process. It is not mandatory. It will be made to work, or it will rot on the vine, in proportion to the support it receives from the ultimate buyer of bushings - the electric power industry. We, as a bushing manufacturer, have no choice but to make the kind of product our customers order. Whether these orders are directed toward the standard, or away from it, will be the factor that can spell success or failure.

Bushing standards mean greatly simplified variety and full interchangeability. No longer must almost every piece of station apparatus be protected by a special spare bushing; a bushing that may not fit any other piece of apparatus; a bushing that has little likelihood of ever being used, and that will become obsolete any time its "parent" apparatus goes out of service. The dollars it has taken in the past to maintain inventories on such a basis, and the other dollars that have gone down the drain due to obsolescence, are far from a small item.

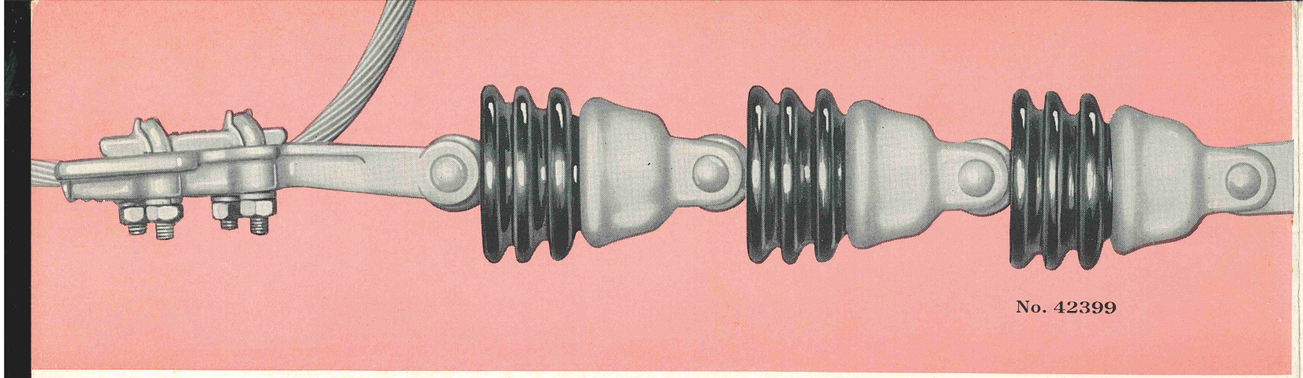
Under the standard, usually one or two spare bushings can function as emergency protection for all apparatus of a given voltage, either transformers or circuit breakers. These spare units can substitute for any other standard bushing. They are not directly related to any specific piece of apparatus, but to all equipment of the same general characteristics. Because of this fact their obsolescence is not dictated by that of "parent" apparatus, and the necessary spare units bought with the first standardized transformer or circuit breaker will ordinarily serve for later equipment without the need for any additional inventory investment.

This, we realize, looks ahead to the day when standardization is in full force. That day is still a long way off. There are thousands of pieces of apparatus, using non-standard bushings, that have an indefinite life ahead of them.

Such facts, however, need not perpetuate the present condition. Over a period of time, a few non-standard spare bushings will probably be used, or uses perhaps can be found for them with a little ingenuity. In every such case, a standard emergency bushing will then enter the picture of protecting this older apparatus as well as the new equipment for which it was originally bought. This is because modern bushings have radically reduced diameters and seldom create a problem of fit in older, larger tank dimensions. Adapters will be needed, but these are neither complicated nor costly. Therefore, while many years lie ahead before full realization of the benefits of standards, some effect will be more or less immediate and each passing year should see further improvement.

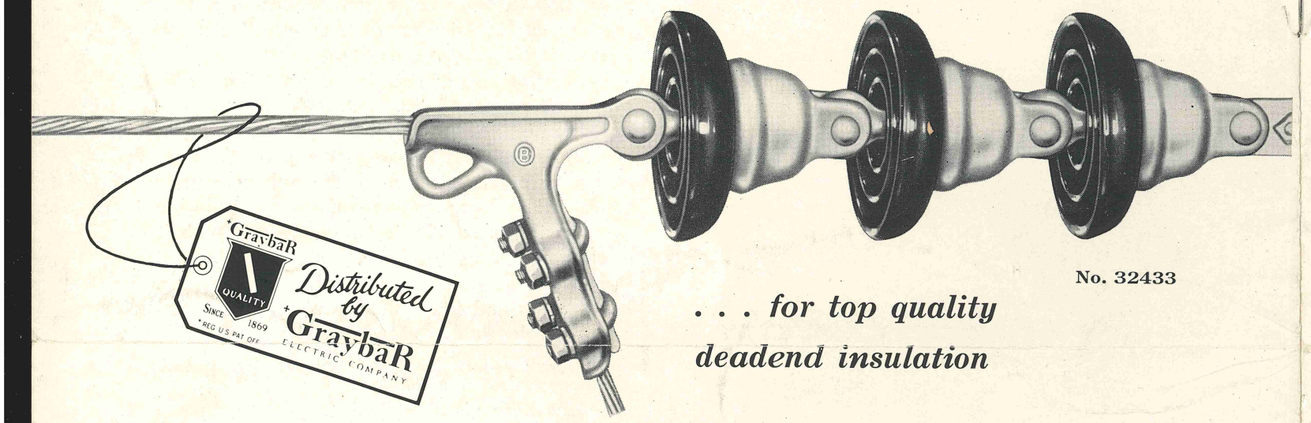
We have discussed only one phase of the question of standards. There are others equally deserving attention and consideration. If individual purchasing or engineering departments have not yet given serious study to the matter, we speak from many years of experience when we recommend that this be done.

—And we repeat: the dollars you spend on bushings are your dollars. How you spend these dollars is your business. And the way you spend them will determine the ultimate success or failure of the present standardization program. It is our belief, however, that many of these dollars need not be spent, and many more need not be wasted, if the ASA bushing standard is supported by the electric power industry.



No. 42399

PICK EITHER ONE . . .



No. 32433

. . . for top quality deadend insulation

Here's another practical example of the O-B approach to preferences by power customers for different products to do basically the same job.

Frankly, the advantages of these two dead-end insulators are virtually equal, as we look at them. So you pick the design you prefer, and we'll be glad to supply it, through Graybar.

The six-inch diameter No. 32433 has an EEI - NEMA approved design, is used in much greater volume than the No. 42399. Also, the price is slightly lower.

The smaller diameter of the No. 42399 provides reduced clearance to simplify the forming of jumper loops. Smaller diameter also reduces the tendency of the insulator to roll, possibly simplifying handling. In hot line work, a pin-type hood can be used over the No. 42399.

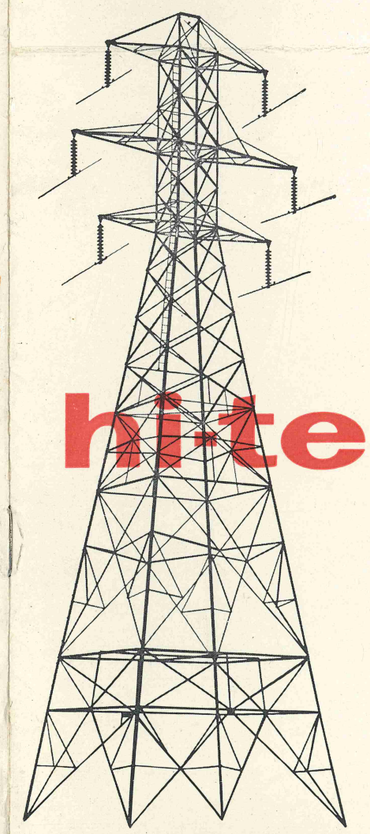
Except to meet specific requirements, most utilities will probably consider these points to be comparatively minor. Both insulators are top quality items, fully capable of giving the long service that you expect of O-B products.

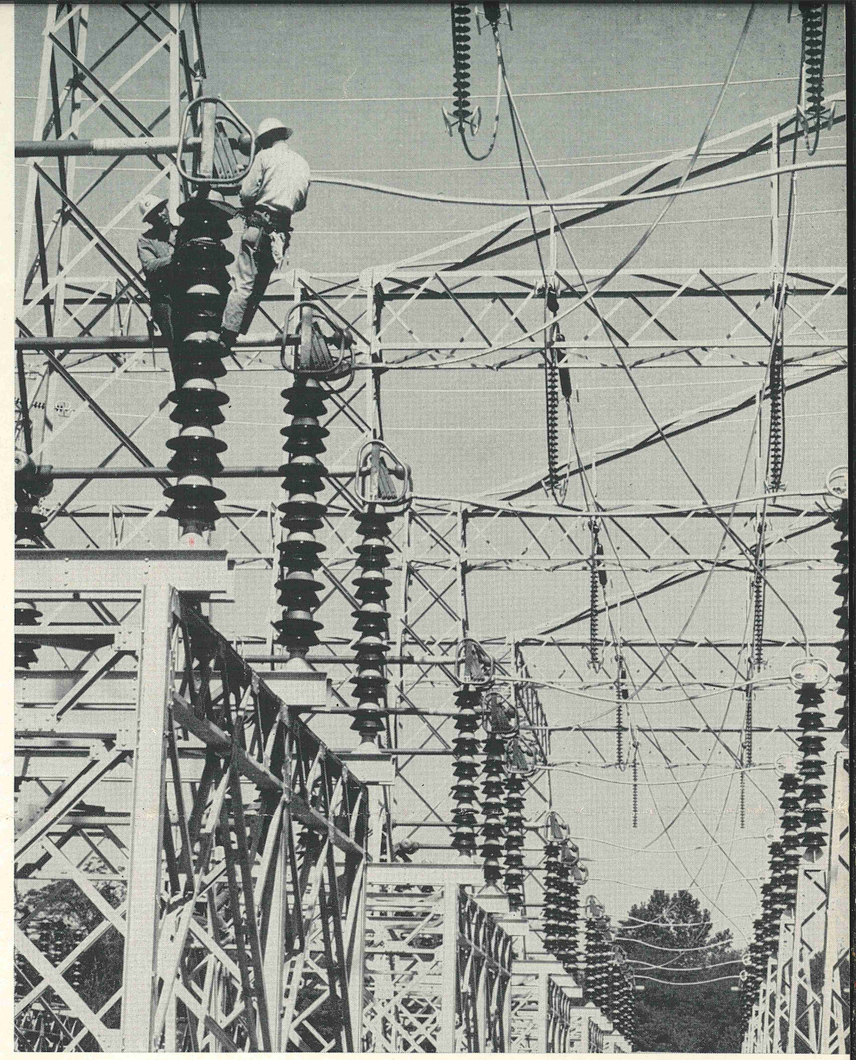
Both insulators and related hardware are conveniently available, from the Graybar houses throughout the country where they are stocked and sold.

Why not discuss your requirements with your local Graybar man? He'll be glad to work with you. Let him do your warehousing for you.

on the cover . . . Standard O-B pincap insulators exceeded every mechanical and electrical test called for in the design of these 330-kv air-break switches. Materials were examined thoroughly -- complete 60-cycle wet and dry flashover and withstand, corona, and complete impulse testing guided the switch design, and eventually confirmed it.

5965-H Printed in U. S. A.





hi-tension news

Volume 25 • No. 6 Published by Ohio Brass Company, Mansfield, Ohio

JUNE 1956

MONOGRAPH #8

How insulator section length affects flashover voltage

In the first monograph we told about our investigation of flashover on suspension insulator strings.

We reported that high overvoltage, short-time impulse flashovers tend to follow a cascade type of path, each unit flashing over individually. Sixty-cycle or critical impulse flashovers tend to follow a tight-string striking distance over the full insulator string length.

In this monograph we will discuss one practical application of this information for designing transmission lines.

Let's state the problem this way:

"In an area where lightning performance dictates the highest possible flashover value for a given string length of suspension insulators, what is the best section length of insulator to use?"

The two photographs shown with this article, tell the story. Let's see what it is.

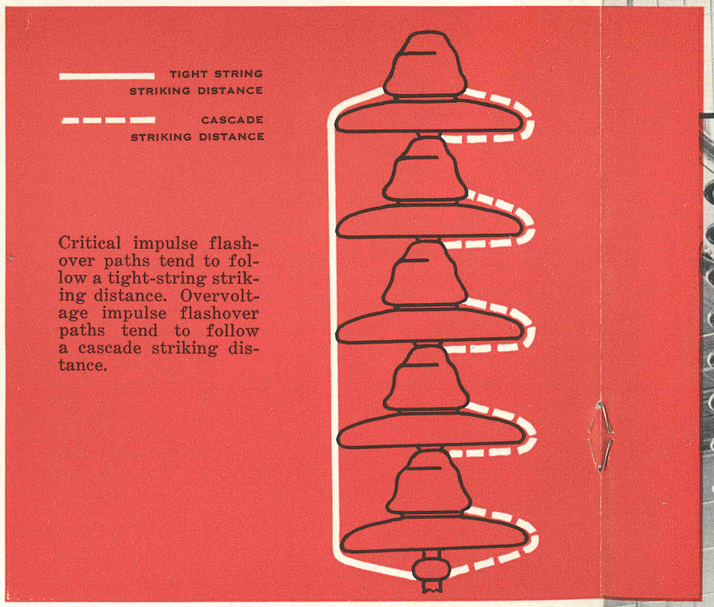
Involved in this test are two strings of insulators -- 13 of the five -¾-inch section No. 32440's (left) with a total string length of 74-¾ inches, and 14 of the five-inch No. 32436's (right) with a total string length of 70 inches. The 13-unit string has a longer tight string length but shorter cascade striking distance than the 14-unit string.

In both photographs the strings are connected in parallel. In the bottom photograph, critical flashover of the shorter length 14-unit string is taking place. Since the 13-unit string has a longer tight-string flashover distance, it doesn't flashover.

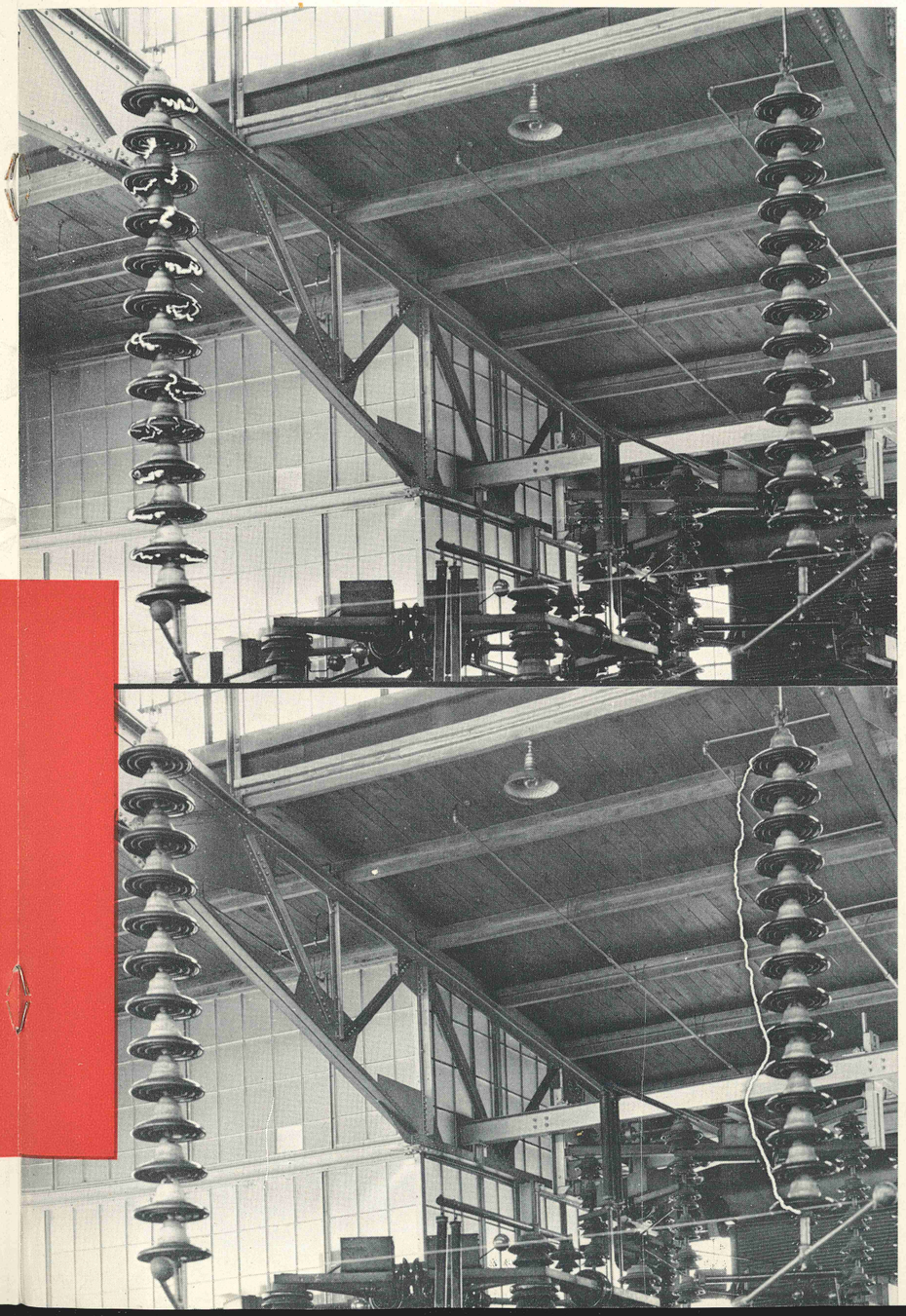
In the top photograph, with an overvoltage two microsecond flashover, the 13-unit string of five and ¾-inch section insulators flashes over, even though it is the longer string. However, the flashover follows a cascade pattern, and the shorter, 14-unit string does not flash over since with more units in the string it has the longer cascade striking distance.

These particular tests were run and photographed in our Barberton Laboratory 14 years ago and show in the second case a 2 microsecond flashover. However, the same principle holds even though a fractional microsecond flashover impulse is used. The characteristics would be the same except the fractional microsecond flashover tends to adhere even more tightly to the surface of the insulator.

So you have the answer to our problem. For a given wave the steep front flashover voltage of strings of standard five and five and ¾-inch insulators is directly proportional to the number of units in the string, regardless of string length. Where lightning performance on shielded lines is marginal, better protection can be obtained in a given string length by using five-inch section length insulators than by using the standard five and ¾-inch insulators, since the five-inch string provides the greater number of units.



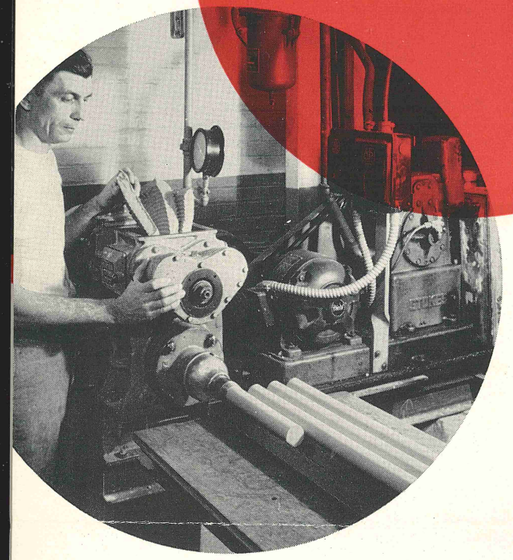
Critical impulse flashover paths tend to follow a tight-string striking distance. Overvoltage impulse flashover paths tend to follow a cascade striking distance.



Here an overvoltage sufficient to cause a two microsecond flashover was applied. The string having the shorter cascade striking distance flashed over.

These two strings of suspension units (13 No. 32440's on the left, 14 No. 32436's on the right) were connected in parallel. The voltage applied caused critical flashover of the 14 unit string which is the string having the shorter tight-string striking distance.

THIS MAN IS USUALLY IN TROUBLE



* TECHNICAL COMPETENCE

Some folks think porcelain clay is almost human. No inanimate stuff could have so much personality or sometimes such a contrary disposition.

To produce a workable raw material, the soft clay is finely shredded under high vacuum in a Pug Mill, in order to remove all air. It is then expelled in cylindrical form by a powerful screw. This is the stock from which all insulators are made. It is called a Pug.

But does the clay cooperate? It shows an amazing memory for this expulsion screw. We have to break-up all orientation of the Pug Mill when we handle this stock or the screw will appear after drying as checks, cracks, and wasted production.

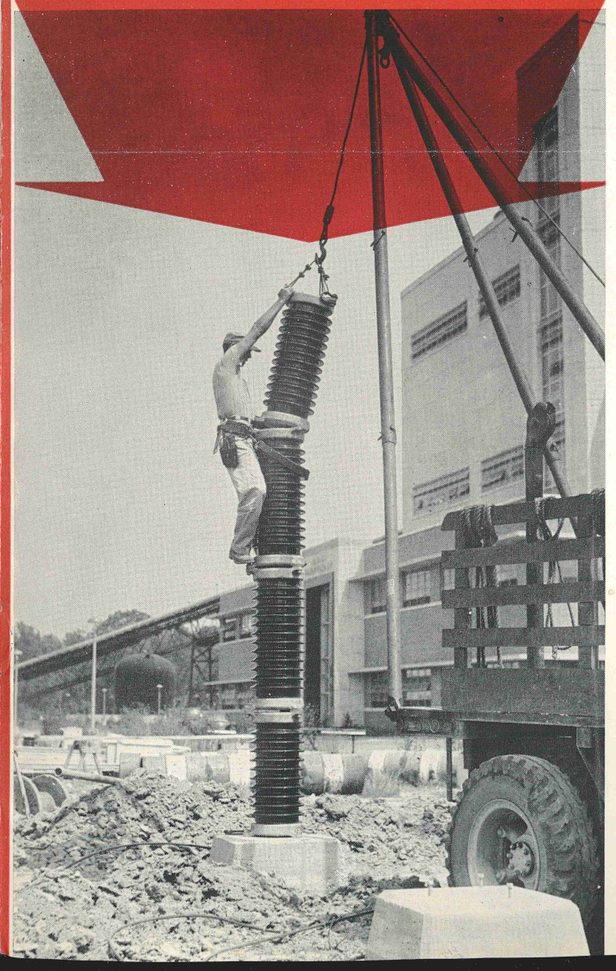
Clay shrinks somewhat more than 10 per cent as it loses moisture, but not in any simple way! Again it remembers how it came from the Pug Mill and, going back to that original form, its axial shrinkage exceeds its radial shrinkage while losing moisture progressing to an air-dry state. But typical of its lack of cooperation, this changes around in the kiln when, during firing, the radial shrinkage of the same clay exceeds the axial shrinkage.

Clay handling takes a lot of know-how and a lot of experimenting. Pottery still involves a considerable degree of "art". New products often pose a whole set of new problems. This hardly fits into efficient factory production methods. Guesses or compromises arrived at in the course of manufacture are no way to be sure of your product. So, O-B has a rather unique approach. A factory within a factory -- our Experimental Pilot Plant -- duplicates every process in miniature. Here, they get into lots of trouble. That's their business. They get out of it, too. That's also their business. When problems get to the factory, they're **solved problems**, and when products come out of the factory, they are **good products!**

This is just one of many practical applications of Technical Competence, the heart of every O-B insulator.

Improved Stacking Principle of Thorex Arrester

Offers Worthwhile Economy and Higher Operating Reliability



Too much is at stake to allow minor details in lightning arresters to overshadow protective performance. If one arrester is definitely better than another, the incidentals are ignored. This is only common sense.

But something else makes sense, too. When a superior arrester also offers some very tangible economies, this may well be another factor in specifying its purchase.

At higher voltages -- 138 kv and above -- the Thorex MPR arrester provides today's finest combination of protective characteristics, along with exclusive internal grading that offsets the hazards of conductive contamination. It can be proved, both technically and service-wise, that the Thorex MPR is the "most arrester" you can buy.

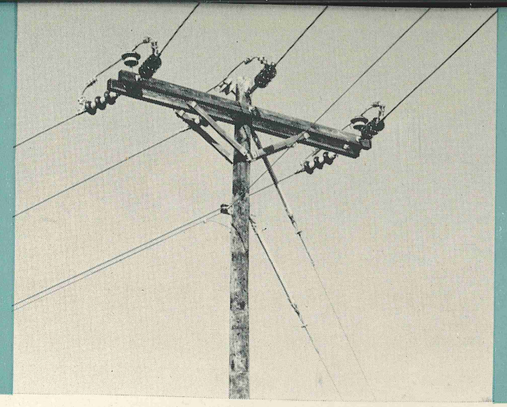
Various ratings of this arrester are built with combinations of 45, 50, and 60-kv units. The 121-kv rating for 138-kv circuits, as an example, is comprised of only two 60-kv components. Even at 330 kv applications, there are only five units used. All end castings are of heavy malleable iron, having great physical strength. Three-bolt stack connections produce ample strength and rigidity in the pole to resist all natural strains. Large units and few bolts permit easy, fast assembly in the field. As has been stated before, an actual example of this was the construction of all three poles of a 230-kv Thorex MPR bank, from the bare piers to final completion, in one hour and 28 minutes by three men and a truck-mounted hoist. Such convenience as this justifies serious consideration.

Another advantage inherent in the use of few large units is the reduction in number of seals. It is an axiom in arrester design that the device is no better than its sealing technique, since air and moisture on the inside can render an arrester inoperative. In spite of the elaborate precautions used in sealing modern arresters, it is only realistic to recognize that the fewer the seals, the greater is the arrester's over-all reliability.

Only fifteen bolts are used for base mounting, stacking, and attachment of the cap and grading ring on a 195-kv Thorex MPR pole for 230-kv service. This pole has only eight seals -- two on each end of the four units. Construction economy and increased reliability are both favored by this O-B design principle. And, when it is built, the Thorex stands as the finest arrester protection you can give your apparatus.

The sum of all bolted joints; base mounting, stacking, and attachment of the grading ring and cap, amounts to using only 15 bolts. This is indicative of the time-saving feature of Thorex MPR lightning arresters.

With 12 or 13.8 KV the accepted distribution voltage level in many systems, already there's speculation as to what the next level will be. To get ready for higher voltages, build distribution deadends with three suspension insulator units.



IF IT'S 12 KV NOW

.....can 22 or 34.5 kv be far behind?

"Today the 12 kv voltage level is almost universally accepted as an answer to 4 kv capacity and regulation problems. However, load growth has placed 12 kv in about the same relative position that 4 kv was 25 years ago. Therefore, it is reasonable to conclude that with continued high rate of load growth, the future will again dictate a change."*

We're not entering an argument on how high distribution voltages are destined to go. We know that local conditions -- the amount invested in the present distribution system, load density per square mile, and type of load -- may rule against immediate increases in voltage.

But from where we sit - getting reports of load increases from practically every part of the country, seeing even the most optimistic predictions fall short time after time - we can see voltages generally going in only one direction -- up!

If the pattern of growth continues, we'll hardly be used to 12 or 13.8 kv until there'll be a jump to 20, or 22 or 23 kv. In fact some authorities right now are advocating going as high as 34.5 kv as soon as possible, at least in new construction where the potential load density will justify it.

This is a little of the thinking behind our current recommendation that new distribution deadends be built with three six-inch suspension insulators.

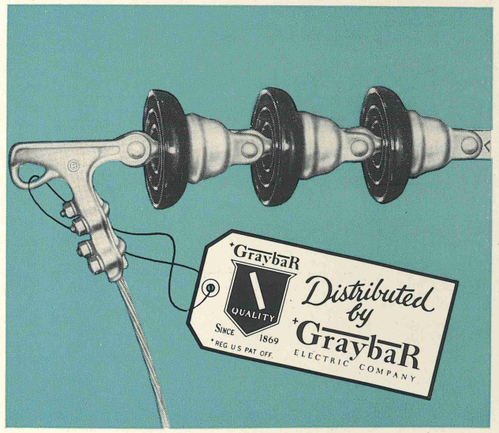
While the lineman is up on the pole, he might as well put in three units as two. The extra cost is very small in comparison to installing the unit three or four years later.

Naturally, we're advocating that the deadding be done with O-B units. Since it developed the first practical suspension insulator de- 1911, O-B has led the industry not only in volume of suspension production but in developing manufacturing controls that assure a product of uniformly high quality. More than 40 million O-B suspension insulators are now in service all over the world.

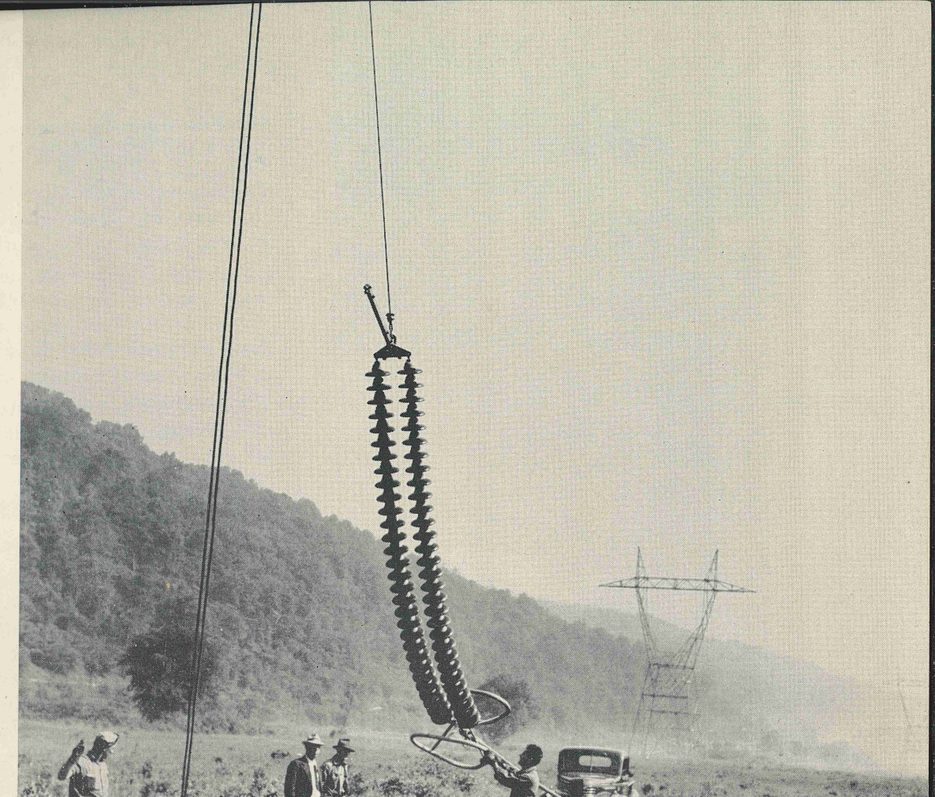
There's also convenience to consider. Since Graybar stocks these six-inch units, you can have them delivered in a few hours, overnight at the latest.

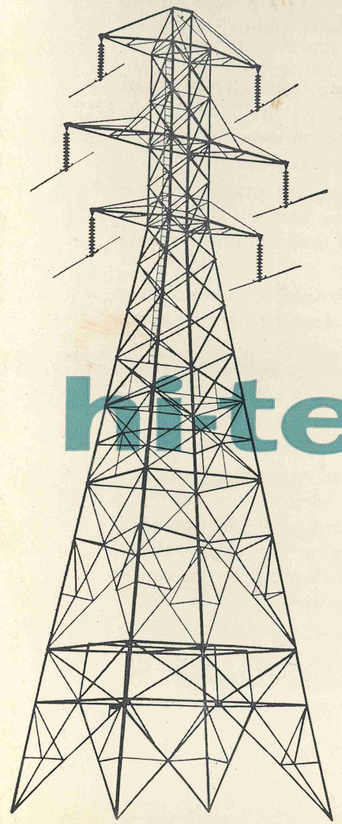
Thus we offer three good ideas in a single package -- use of three suspension units instead of two on new or rebuilt deadends, use of a brand that's been performing successfully for more than a generation, and quick delivery through Graybar.

* "12-KV -- AND THEN WHAT?" -- By H. L. Hess, Public Service Company of Indiana, Inc., presented to AIEE Great Lakes District Meeting, April 16-18, 1956, Fort Wayne, Indiana.



5968-H Printed in U. S. A.

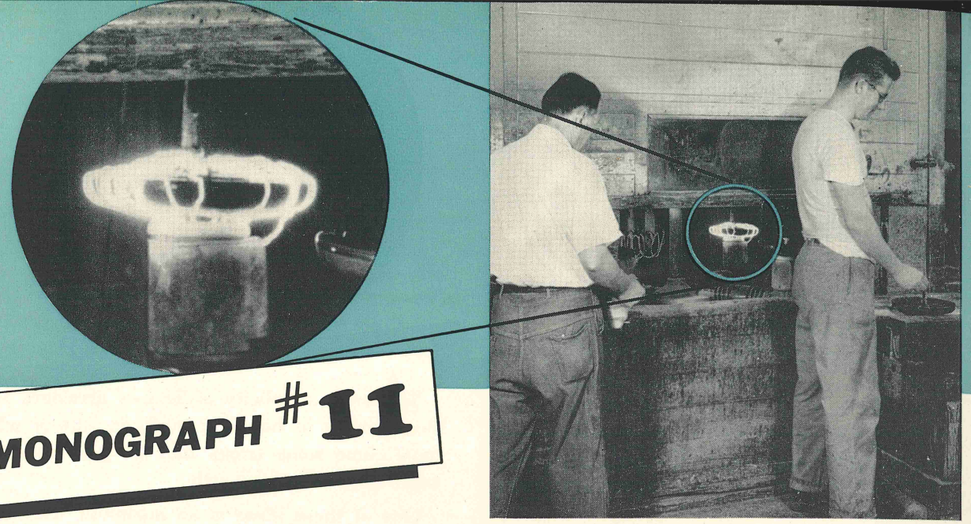




extension news

Volume 25 • No. 9 Published by Ohio Brass Company, Mansfield, Ohio

SEPTEMBER 1956



MONOGRAPH #11

Put the high frequency reel test and the low frequency pan test together, and you have the "kick-reel" test -- the final electrical exam for O-B suspension insulators.

Final Exam for Suspension Insulators

"Kick Reel" is last of three 100% Electrical Tests

In previous monographs we discussed the reel or high frequency test (Monograph No. 9 -- July, 1956 HI-TENSION NEWS) and the pan or low frequency test (Monograph No. 10 -- August, 1956, HI-TENSION NEWS).

After assembly, all suspension insulators receive a "kick reel" test. This is a combination of the reel and the pan tests with each insulator being subjected to 60-cycle flashover voltage upon which is superimposed one or more high frequency oscillations per half cycle.

The physical and mechanical operation of the kick-reel test is much like that of the reel test. Each insulator is placed on a revolving reel. The four-position reel carries each insulator from the loading position through the test position to the unloading position where it is removed and another piece put in its place.

Voltage is applied to the insulator for five seconds. Initially during each half cycle, voltage from a 60-cycle power transformer is applied until the insulator flashes over. While voltage is building up, a capacitor arranged in parallel with the insulator is being charged. Once flashover occurs, the capacitor discharges through an air-core reactor, setting up a high frequency oscillation. This oscillation is in the order of two megacycles per second.

The oscillation provides the high frequency part of the test. There are three to five wave trains of high frequency oscillation on each half cycle of the power frequency voltage. Each wave train is highly damped so that it lasts but a few cycles of its two-megacycle frequency. Only the first half cycle has a high peak voltage.

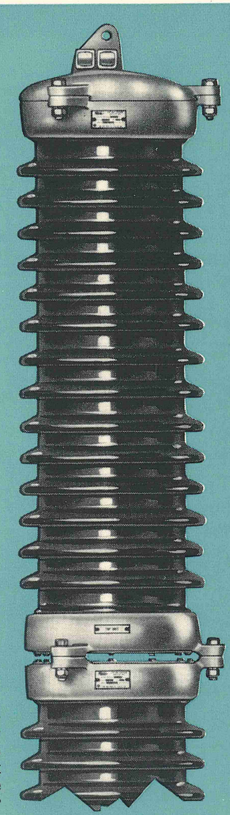
Several flashovers seem to be occurring simultaneously as the insulators are observed. It is probable that every wave train during each half cycle follows the same arcing path, but that the trains for succeeding half cycles establish new paths. Thus we see arcs spread over the surface of the insulator.

Once flashover occurs, voltage of flashover magnitude is applied continuously during each 60-cycle wave. There's no "rest period" after the first flashover while voltage builds up again.

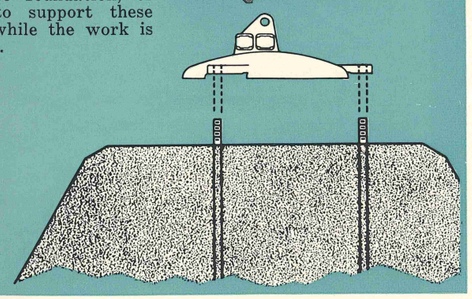
Once it passes the kick-reel test, there's no question about the insulator's capacity to give reliable electrical service. Remember, this is the third routine electrical test that **every** suspension insulator gets before it leaves the factory. More than 40 million O-B suspension insulators have passed this test since it was started in 1914. They've gone out to compile outstanding service records all over the world. Good as their record has been, we're confident the insulators that are passing the test today will do even better!

A handy tip for installing Thorex Lightning Arresters

suspension cap makes ideal template for concrete foundation construction



Upper end of typical Thorex MPR lightning arrester showing normal location of suspension cap. In regular base mounted applications, this cap serves as a support for line connectors, and gives the arrester a more finished appearance. Prior to installation, the cap makes an ideal template for locating mounting bolts in concrete work.



Because location and size of mounting holes in the suspension cap is identical to those in arrester end castings, the cap may be used to check position of bolts in the concrete foundation, or even to support these bolts while the work is setting.

The basic simplicity of Thorex arresters leads to a variety of handling methods, out of which have come some tricks that we pass along for what they may be worth.

One of these ideas is an ingenious use of the suspension cap which is regularly furnished with all Thorex MP and MPR types, and may be had for the GP on order.

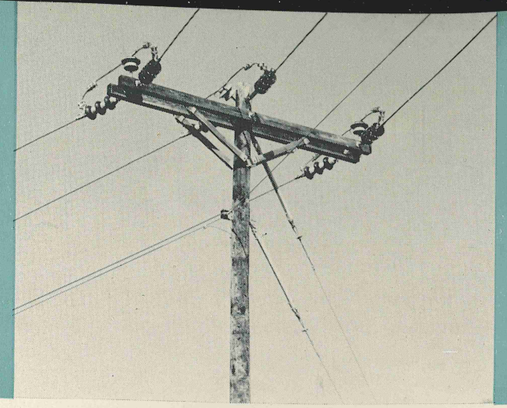
Quite commonly, Thorex arresters are set on concrete foundations. Three mounting bolts or studs are imbedded in this work. While holes in the arrester base casting provide tolerance for positioning the mounting bolts, there is always the possibility of excessive error in this operation.

When the concrete is still soft, permitting final adjustment of bolt position, the suspension cap may be slipped over these bolts for an accurate check. The cap is light and easily handled. The bolt holes are duplicates of those in the arrester end castings. If the cap fits the mounting bolts, so will the arrester. Therefore, it functions as a template. Since there is a cap for every arrester pole, one may be left in position on each foundation until the concrete has set.

There have been cases where mounting bolts have been tightly attached to the cap by using a nut on each side of the three lugs. This assembly is lowered into the soft concrete. It is not disturbed until the foundation hardens. This assures absolute positioning of the bolts but calls for a little ingenuity in handling, as the concrete under the cap must be troweled flat.

In any event, depending on how individual crews care to work, the Thorex suspension cap makes an ideal template for positioning the mounting bolts. Thus its use greatly simplifies both the cement work and later construction of the arrester.

With 12 or 13.8 KV the accepted distribution voltage level in many systems, already there's speculation as to what the next level will be. To get ready for higher voltages, build distribution deadends with three suspension insulator units.



IF IT'S 12 KV NOW

.....can 22 or 34.5 kv be far behind?

"Today the 12 kv voltage level is almost universally accepted as an answer to 4 kv capacity and regulation problems. However, load growth has placed 12 kv in about the same relative position that 4 kv was 25 years ago. Therefore, it is reasonable to conclude that with continued high rate of load growth, the future will again dictate a change."*

We're not entering an argument on how high distribution voltages are destined to go. We know that local conditions -- the amount invested in the present distribution system, load density per square mile, and type of load -- may rule against immediate increases in voltage.

But from where we sit - getting reports of load increases from practically every part of the country, seeing even the most optimistic predictions fall short time after time - we can see voltages generally going in only one direction -- up!

If the pattern of growth continues, we'll hardly be used to 12 or 13.8 kv until there'll be a jump to 20, or 22 or 23 kv. In fact some authorities right now are advocating going as high as 34.5 kv as soon as possible, at least in new construction where the potential load density will justify it.

This is a little of the thinking behind our current recommendation that new distribution deadends be built with three six-inch suspension insulators.

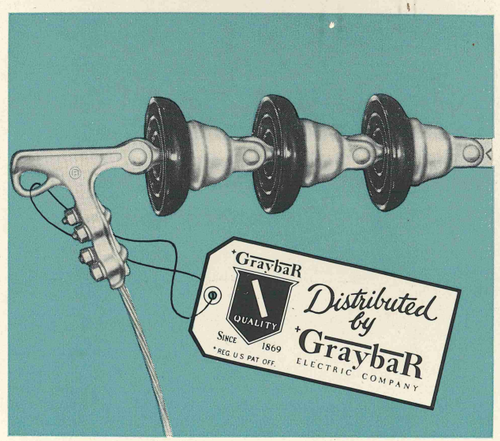
While the lineman is up on the pole, he might as well put in three units as two. The extra cost is very small in comparison to installing the unit three or four years later.

Naturally, we're advocating that the deadending be done with O-B units. Since it developed the first practical suspension insulator design in 1911, O-B has led the industry not only in volume of suspension production but in developing manufacturing controls that assure a product of uniformly high quality. More than 40 million O-B suspension insulators are now in service all over the world.

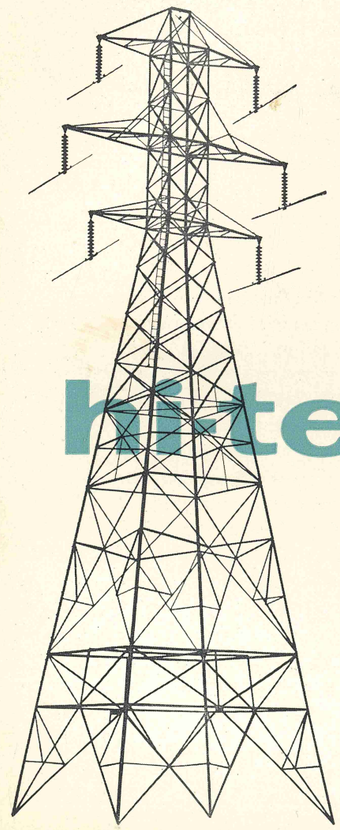
There's also convenience to consider. Since Graybar stocks these six-inch units, you can have them delivered in a few hours, overnight at the latest.

Thus we offer three good ideas in a single package -- use of three suspension units instead of two on new or rebuilt deadends, use of a brand that's been performing successfully for more than a generation, and quick delivery through Graybar.

* "12-KV -- AND THEN WHAT?" -- By H. L. Hess, Public Service Company of Indiana, Inc., presented to AIEE Great Lakes District Meeting, April 16-18, 1956, Fort Wayne, Indiana.



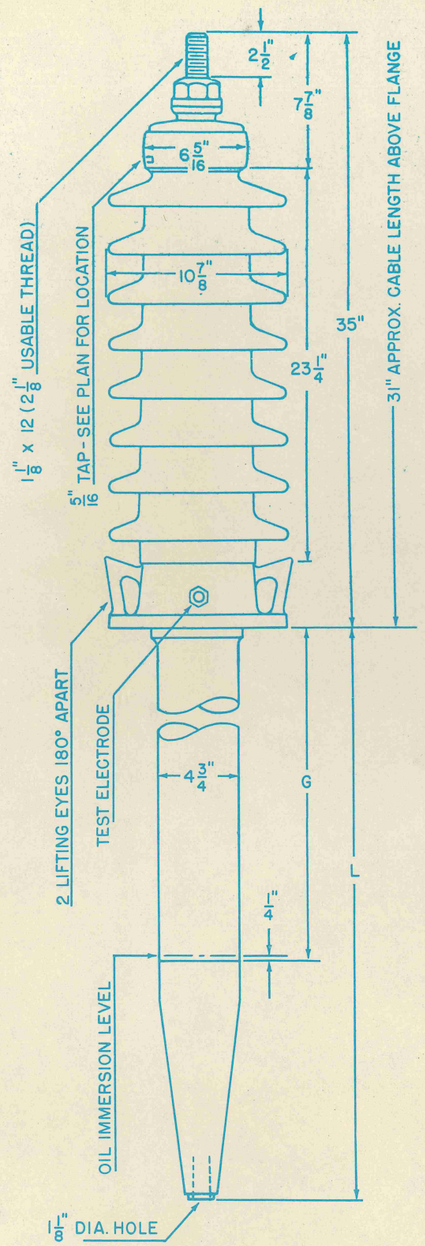
5968-H Printed in U. S. A.



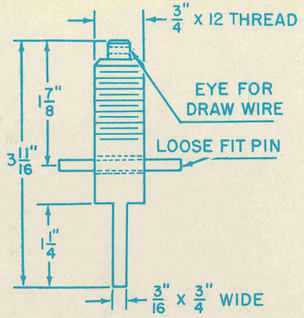
b tension news

Volume 25 • No. 9 Published by Ohio Brass Company, Mansfield, Ohio

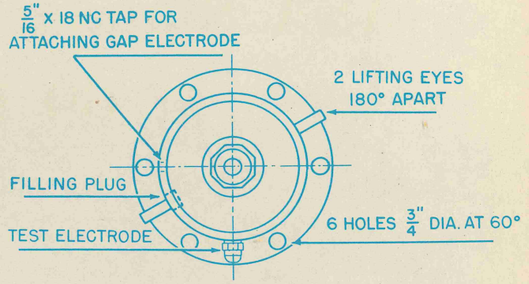
SEPTEMBER 1956



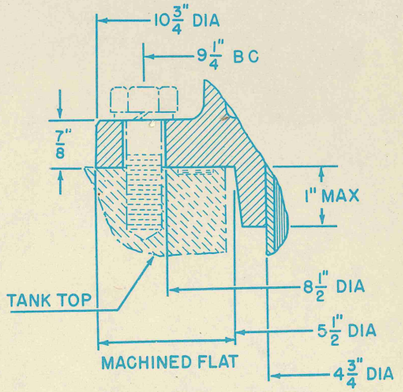
CATALOG NUMBER	GROUND SLEEVE LENGTH	TOTAL LENGTH BELOW FLANGE
	G	L
45125	16 3/4"	30 1/2"
45126	21 1/4"	35"
45127	27 1/4"	41"



INNER TERMINAL FOR BRAZING TO CABLE



PLAN VIEW



SECTION THROUGH MOUNTING FLANGE

OHIO BRASS COMPANY

MANSFIELD - - - - - - - - OHIO

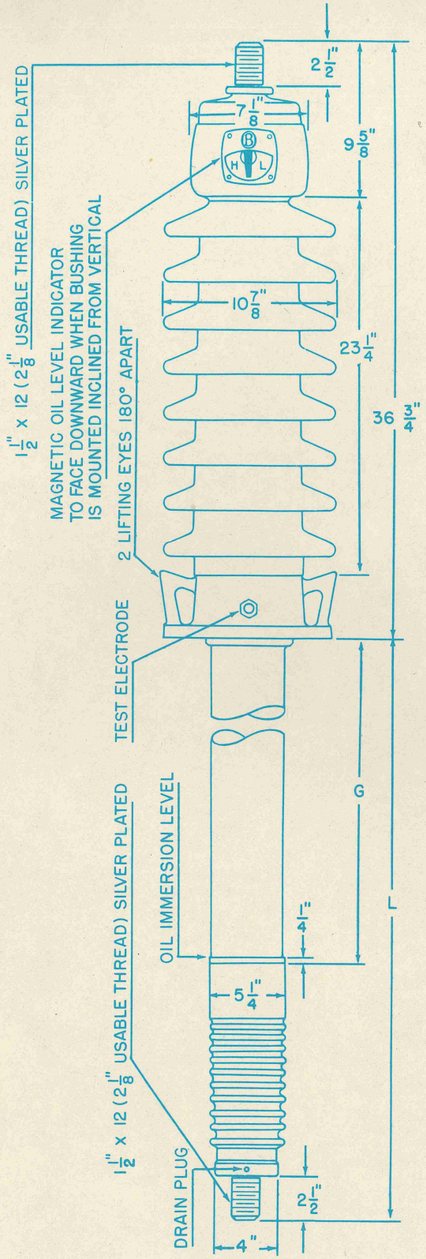
LK-30 BUSHING

69-KV

DRAW-LEAD - - 400 AMPERES

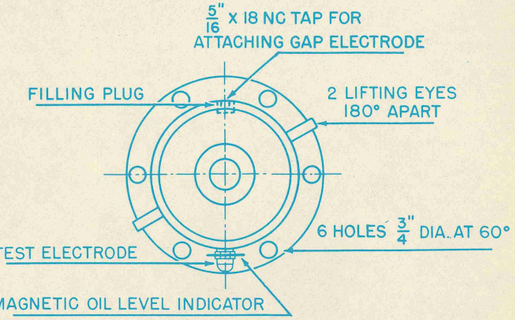
ASA-NEMA STANDARD

A-4538



CATALOG NUMBER	GROUND SLEEVE LENGTH	TOTAL LENGTH BELOW FLANGE
	G	L
*45428	*16 3/4"	*37 1/2"
45429	21 1/4"	38"
45430	27 1/4"	44"

*ASA CIRCUIT BREAKER STANDARD



PLAN VIEW

SECTION THROUGH MOUNTING FLANGE

OHIO BRASS COMPANY

MANSFIELD - - - - - - - - OHIO

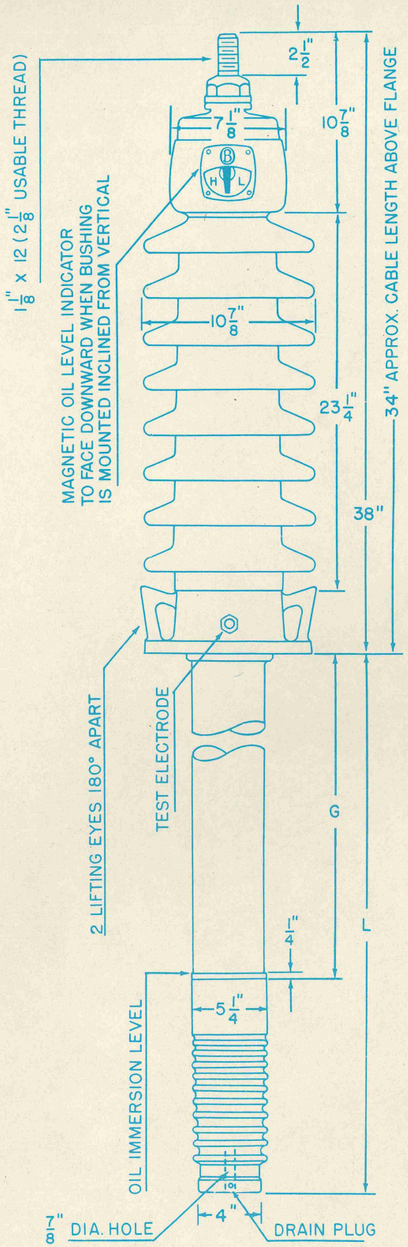
GK-30 BUSHING

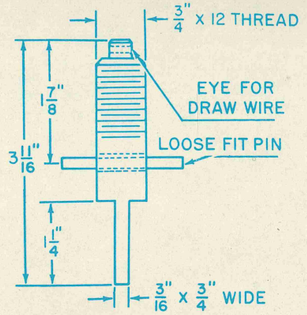
69-KV

SOLID CONDUCTOR - - 1200 AMPERES

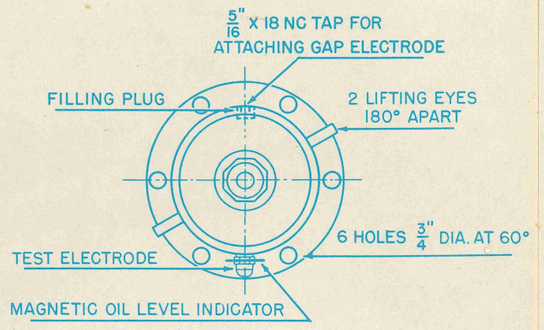
ASA-NEMA STANDARD

A-4541

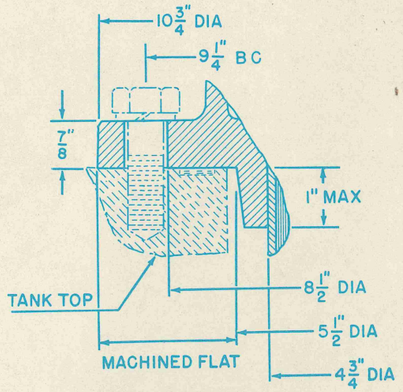




INNER TERMINAL FOR BRAZING TO CABLE



PLAN VIEW



SECTION THROUGH MOUNTING FLANGE

CATALOG NUMBER	GROUND SLEEVE LENGTH	TOTAL LENGTH BELOW FLANGE
	G	L
45413	16 3/4"	30 1/2"
45414	21 1/4"	35"
45415	27 1/4"	41"

OHIO BRASS COMPANY

MANSFIELD - - - - - - - - OHIO

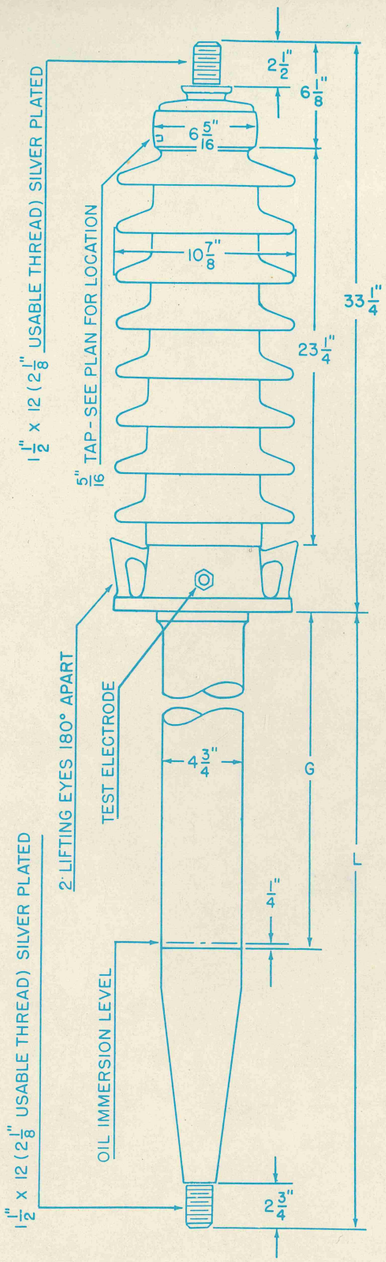
GK-30 BUSHING

69-KV

DRAW-LEAD - - 400 AMPERES

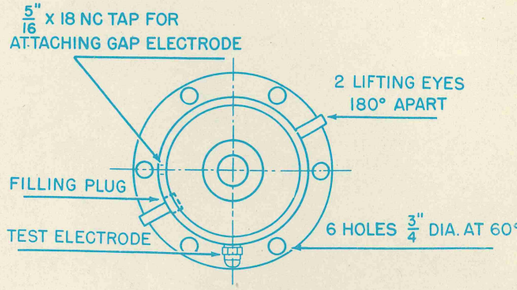
ASA-NEMA STANDARD

A-4540

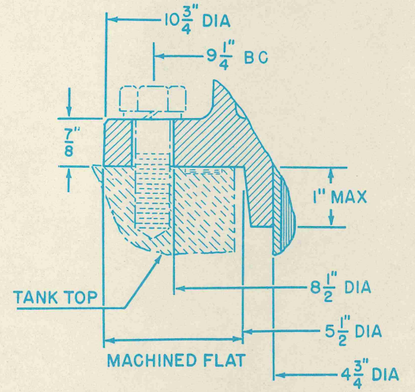


CATALOG NUMBER	GROUND SLEEVE LENGTH	TOTAL LENGTH BELOW FLANGE
	G	L
*45152	*16 3/4"	*37 1/2"
45153	21 1/4"	38"
45154	27 1/4"	44"

*ASA CIRCUIT BREAKER STANDARD



PLAN VIEW



SECTION THROUGH MOUNTING FLANGE

OHIO BRASS COMPANY

MANSFIELD - - - - - - - - OHIO

LK-30 BUSHING

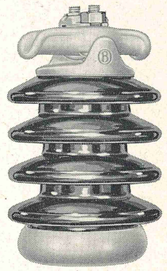
69-KV

SOLID CONDUCTOR - - 1200 AMPERES

ASA-NEMA STANDARD

A-4539

purchasing agent's notebook



O-B Line Post Insulators

Well suited for "sub-transmission" applications, the O-B Line Post is sometimes favored because of its neat appearance and self-cleaning characteristics where rainfall is plentiful. Line Posts are generally used both in distribution at 23 kv and up and in transmission insulation to 69 kv. They are available with either tie top or Clamptop fittings.

Radio interference is eliminated because Line Post Insulators are inherently free from it. Line Posts made by O-B meet standard requirements for radio-free insulators. For installation on wooden crossarms, the Line Post is available with a long stud, for steel crossarms it can be ordered with a short stud. It is also available without a stud.

A large number of variations can be found in just one basic size Line Post. For example, with any stud length it is available with the tie-top head, or the Clamptop head with small, medium or large clamp, or just the base casting with pintles of the Clamptop without loop. This adds up to 15 possible head and stud combinations with one basic size of porcelain. This flexibility makes the O-B Line Post adaptable to many different types of installations.

Short, sturdy petticoats on the Line Post allow strong resistance to impact from stones, bullets or flashover damage. Compactness of design lessens the possibility of breakage or chipping.

The manufacture of the O-B Line Post is carried out under rigid quality control procedures and each one is tested and inspected many times before packaging. The malleable iron base and the Clamptop components are all made in Ohio Brass' own foundry for perfect fit and highest performance.

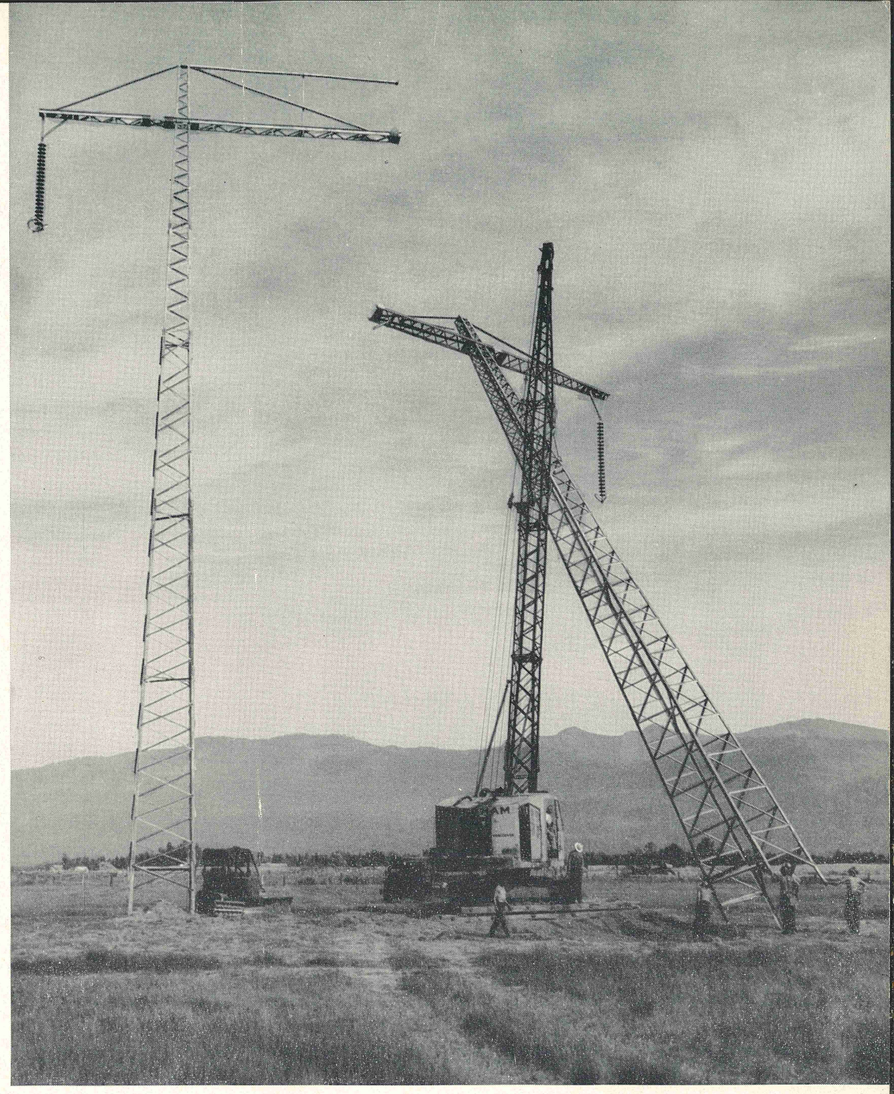
An O-B representative will be glad to discuss the application of Line Posts to specific distribution or transmission problems.

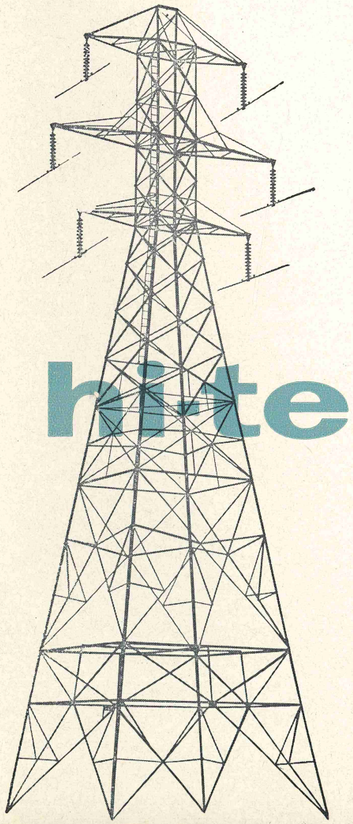
no radio noise problems

there's a line post for every need

durable and dependable

6025-H Printed in U. S. A.

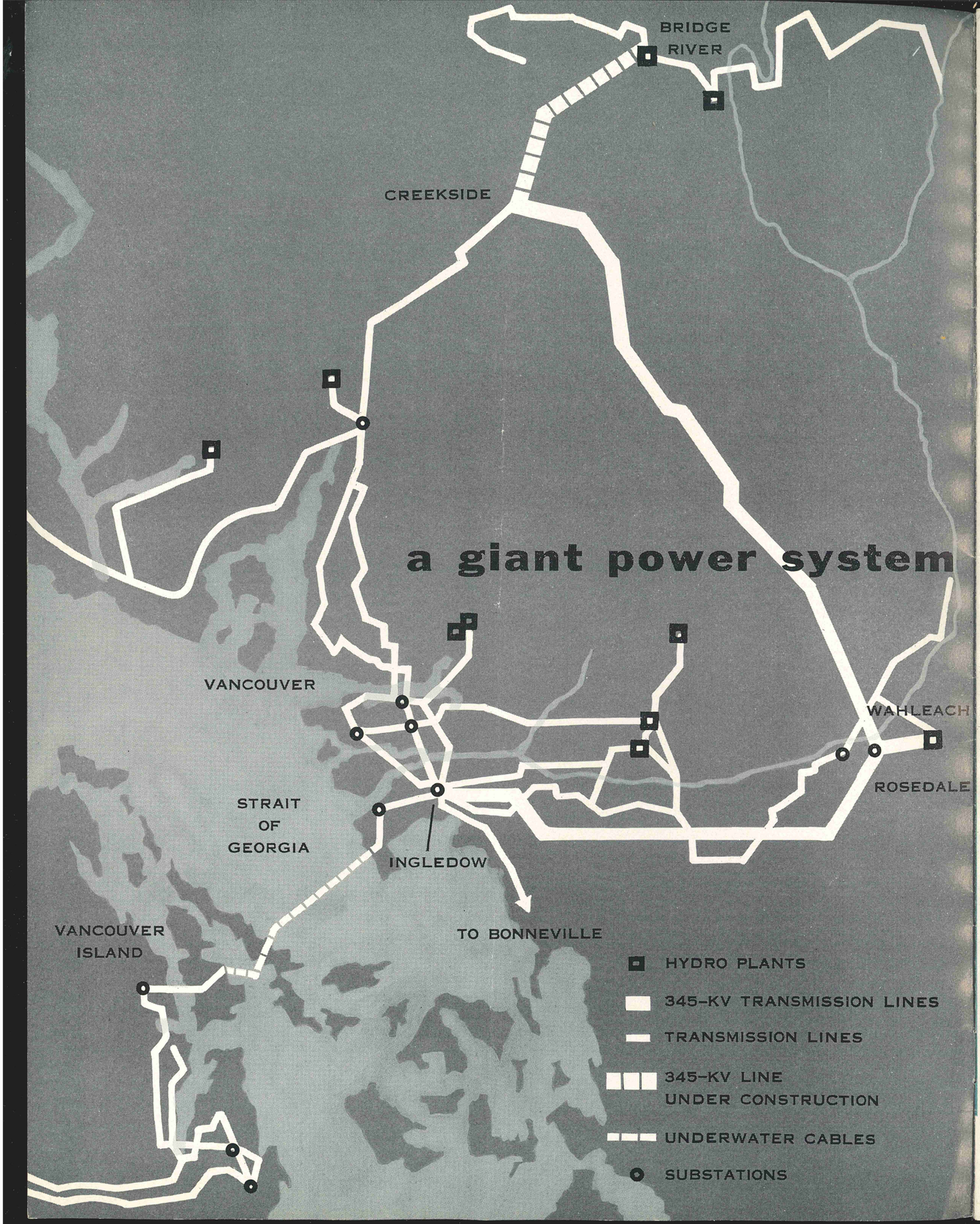


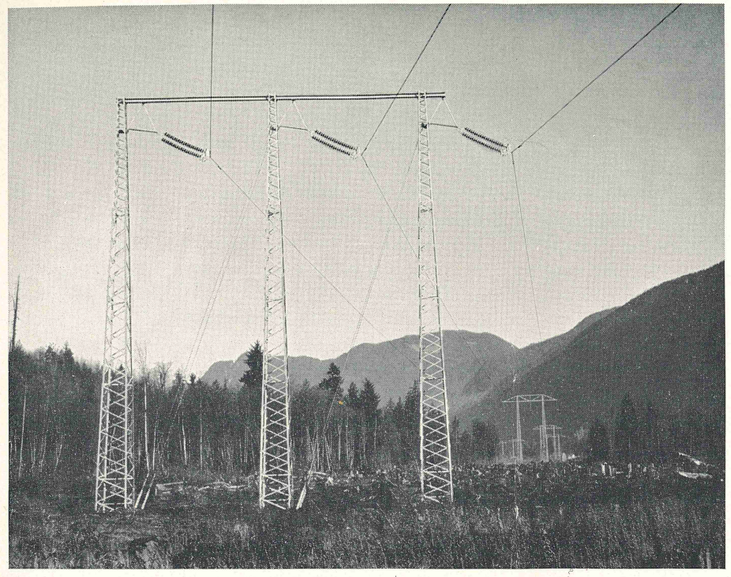


hi-tension news

Volume 26 No. 6 Published by Ohio Brass Company, Mansfield, Ohio

JUNE 1957





Ingledow-Wahleach angle tower. Line was initially built with single conductor. Second conductor has now been added.

grows in the land of the giants

British Columbia Electric expands extra-high voltage grid, plans for six million horsepower by 1980

According to old Indian legends, huge, hairy, eight-foot giants or Sasquatches, once lived in the Harrison Lake region of British Columbia.

Unfortunately, they weren't available to help with construction of the Rosedale - Creekside - Bridge River line of British Columbia Electric Company, a line not yet completed that will eventually operate at the extra-high voltage of 345-kv.

The services of giants would be helpful in the mountainous terrain. Along Harrison Lake, the land is so rough, it was necessary to use barges last summer to get material to tower sites. On one eight-mile section of the line, all material had to be "high-lined" to the sites.

If the giants were present, they not only would be impressed by the Rosedale-Creekside-Bridge River construction. which is still in progress, they also no doubt would be awe stuck by many of the other projects being carried out by B. C. Electric.

Even in an industry where big expansion programs and big plans are commonplace, the British Columbia Electric Company has a growth story that is remarkable.

While its territory is neither heavily populated nor highly industrialized at present, the rate of growth is such that BCE is seriously considering an expansion program that will increase generating capacity by six million horsepower by 1980, compared with the 750,000 hp capacity of today.

The BCE expansion has already had more than its share of spectacular projects . . . the Bridge River Hydro Electric Development with its 230-kv line through the rugged coast range to Vancouver . . . the recently laid submarine cable transmitting power at 132,000 volts between the mainland and Vancouver Island, a distance of 43 miles . . . the 132,000-volt Cheekye - Powell River line which has one of the world's four

longest spans -- 10,100 feet from tower to tower.

Recently, the company announced its willingness to initiate development of the Columbia river power sources in Canada. This may call for transmitting power to Vancouver at up to 600,000 volts a. c. or d. c., which probably should be classed as extra-extra high voltage.

B. C. Electric already is well into the business of extra-high voltage transmission. A 345-kv grid has been under construction since 1952, and higher voltages are under study. Part of the 345-kv grid is already in service at 230-kv, and by the fall of 1957 the grid is scheduled to be operating at 345-kv.

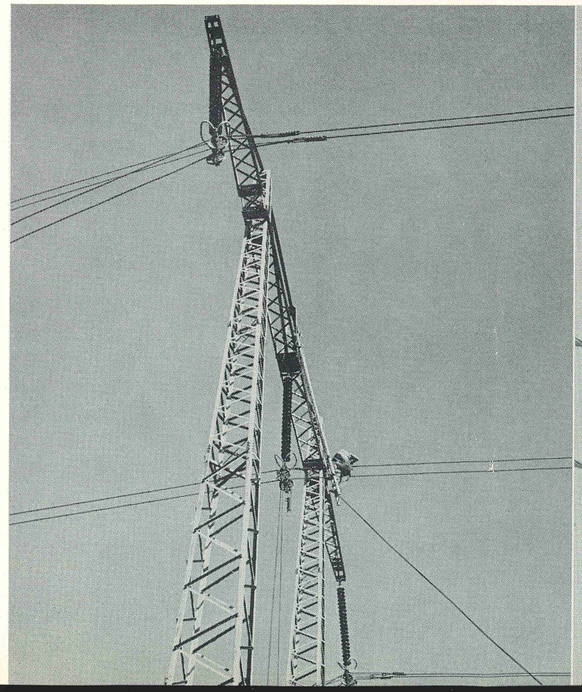
The B. C. Electric system is a logical one for extra-high voltage transmission. Most of the hydro-electric power sources used by the company lie up to two hundred miles north of Vancouver where most of the power is consumed. Most of the territory through which the transmission lines go is mountainous and heavily forested, making construction and maintenance serious problems.

Before deciding to go into extra-high voltage transmission, B. C. Electric studied European experience. It was decided that EHV offered an economical method of transmitting large blocks of power and that the use of twin bundled conductors would further increase the advantages of EHV.

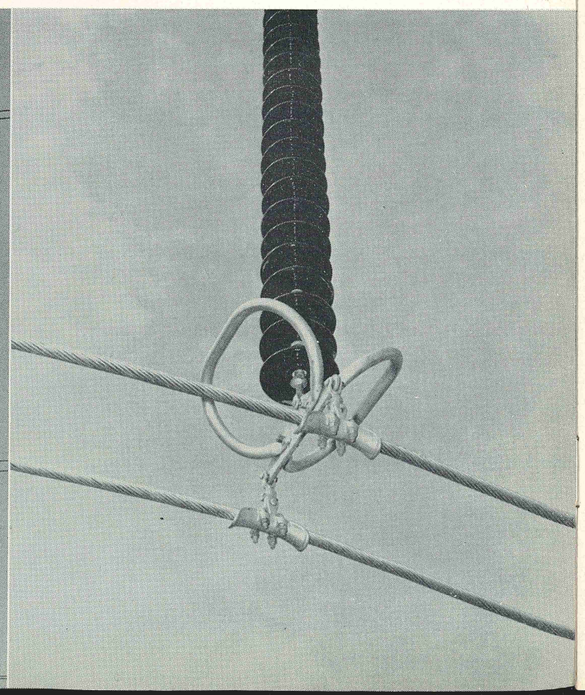
The initial plan was to use lines similar to the 380-kv lines built by the Swedish State Power with bundled conductors and mast or portal type towers. The structures ultimately used resembled the Swedish towers but the voltage was dropped to 345-kv because equipment rated for that voltage was readily available.

Structural tests were made before building the first line up the Fraser River Valley from Ingledow substation at Vancouver to a new generating plant -- Wahleach station -- near Jones Lake, a distance of 64 miles.

Ingledow-Wahleach restringing and tensioning of 795 MCM ACSR Drake conductors. It was necessary to resag the old conductor when tensioning in the added phase conductor.

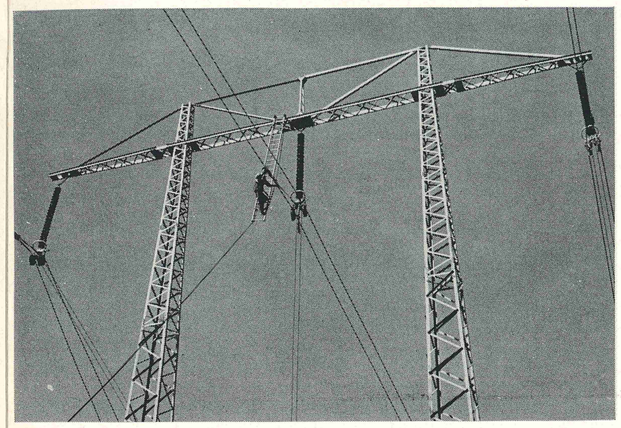


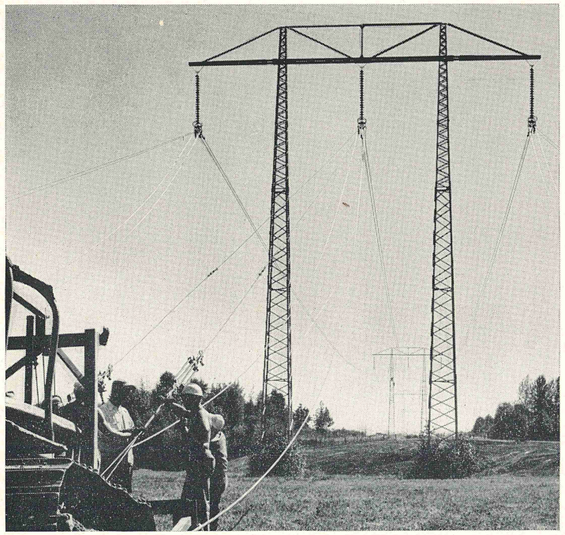
Ingledow-Wahleach hardware, conductor and insulation arrangement. Twenty-one 25,000-pound O-B insulators were used. Insulators and hardware were designed by O-B to hold corona characteristics and RIV to 230-kv level.



Sagging in the bundled conductor on Ingledow-Wahleach. Since it was impossible to get identical side conditions between two conductors, a variation of sag limit to two inches was permitted.

Ingledow-Wahleach line follows Fraser River Valley and runs mostly through flat country. All stringing was done under moderate tension conditions, conductor being supported by lagging when it touched the ground.





As a result of the tests, it was decided that the same masts could be used for angle and deadend towers as for the suspension towers. Crossarms supporting the outside phases have a special link that fails if the conductor breaks. It bends and allows the arm to swing into line with the conductor, relieving the load on the tower. Replacing the broken or bent link is a simple maintenance operation.

The conductor selected for the Ingledow-Wahleach line was Drake 795 MCM ACSR. Canadian Ohio Brass Company was asked to make laboratory studies to determine conductor spacing and the type of hardware necessary to assure minimum corona and radio interference and proper insulation.

It is interesting to note that B. C. Electric did not specify complete elimination of corona and radio interference but asked that they be no higher than on existing 230-kv lines.

The test arrangement consisted of two 30-foot lengths of Drake conductor, spaced at 18-inch centers and mounted approximately 10 feet above the laboratory floor. Control rings at the deadend position prevented radio influence voltage and corona from sources other than the test specimen. All tests were conducted in accordance with appropriate standards.

Tests showed that the mutual shielding effect of the two conductors lowered the radio influence level and that conductor clamps in the suspension position did not cause radio influence voltage. It was necessary to provide a grading shield of aluminum alloy rings to redistribute the voltage on the insulator string, lowering the gradient on the two or three line units and to shield the yokes.

Twenty-five thousand pound suspension insulators in single strings were used for all suspension points except for certain longer spans or where line angles required double suspension strings.

Deadending used two strings of 25,000-pound units for each conductor, making a total of four strings for each phase deadend. Each conductor was deadended independently, with a separate anchor to the tower for each pair of insulator strings. A spacer bar was inserted at the line end of the strings to keep the insulators apart.

The independent anchoring arrangement as compared to hanging both pairs of insulator strings from the same yoke was used for several reasons. The need for a heavy, expensive yoke was eliminated.

In construction, sagging of conductors could be done without the need to match exactly the amount of sag for the two conductors. In service, under a sudden shift in load, the conductors and their supporting insulators could move independently so the entire arrangement would not be adversely affected. If it would become necessary to drop one of the conductors, the other could be left in the air. All these points, plus other favorable factors, ruled in favor of the independent system of anchoring used on the deadends.

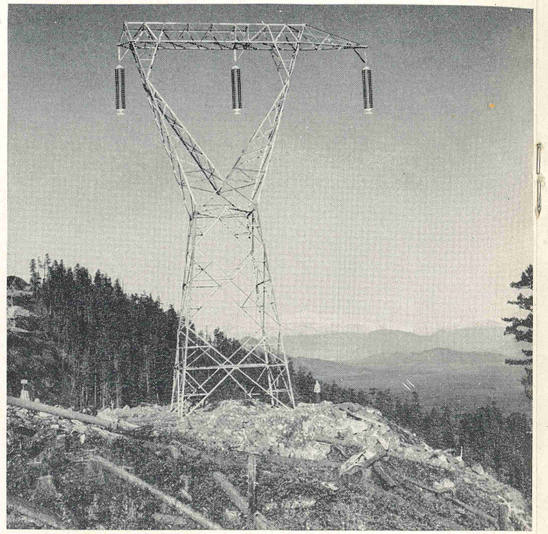
Eighteen inch conductor spacing was accepted and aluminum alloy spacer bars and clamps were developed with the spacer having maximum longitudinal spacing of 300 feet. This was based on the performance of the Swedish line over a period of three winters, and proved on B. C. Electric's own lines, which have been in service through two winters.

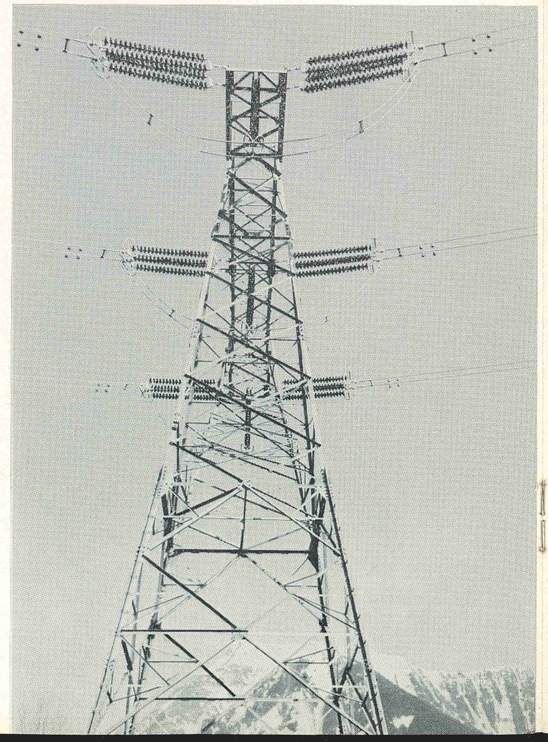
Standard catalog conductor clamps were used and most other items were also standard catalog fittings. The yoke plates all have holes for attachment of shields and arcing horns if future performance indicates the need of an arcing horn at the ground end of the string. Armor rods were used throughout.

Most of the Ingledow-Wahleach line is in the relatively flat Fraser Valley, the Ingledow end going over slightly rough terrain out of the Fraser Valley to the suburbs of New Westminster, just east of Vancouver.

The line was completed in 1952 for operation at 230-kv initially; however, only one conductor per phase was installed for this operation. Insulators and pertinent hardware were installed for full 345-kv operation, so that the installation of the second conductor per phase would be a relatively minor operation. In 1955 and 1956 the second conductor was added to each phase; however, it developed that it was not practical to string new conductor alongside old conductor due to tension and sag problems.

The second line in the EHV grid -- Rosedale, Creekside, Bridge River -- passes through mountainous country, which, according to Indian legend, was once the home of giants.





Angle tower on Rosedale, Creekside, Bridge River line. This line used lattice type steel towers, considered more suitable to rough terrain.

Because of the load carried over this line from the Wahleach plant, only three summer months could be devoted to linework. In 1955 working on the Vancouver half of the line, half of the existing conductor was taken down and re-strung parallel to the existing single conductor. It was necessary to resag the old conductor when tensioning in the added phase conductor. The second half of the line as far as Rosedale, 60 miles from Vancouver, was completed in 1956. (Rosedale is the terminal switching station from the Rosedale-Creekside-Bridge 345-kv line.)

In stringing the two conductors per phase, it would have involved considerable unnecessary expense to have the two conductors identically sagged; therefore, it was necessary to set up a practical construction specification, and a variation of sag to a limit of two inches was permitted.

Inspection of the completed conductor was made at the time of attaching the spacer units. Any abrasion or foreign matter on the conductor was removed as a trolley was rolled along the conductor.

All stringing was done under moderate tension conditions, conductor being supported where it touched the ground by lagging; hence, there was a minimum amount of damage to the conductor.

Energization at 345-kv is planned for the Ingledow-Rosedale section in the fall of 1957.

Stringing Rosedale, Creekside, Bridge River line through rough country near Lillooet Lake. Care was needed with conductor under tension to keep conductor off ground and rocks.

ROSEDALE-CREEKSIDE-BRIDGE RIVER 345-KV TRANSMISSION LINE

Construction of this section of the 345-kv grid was started in 1954 and by the fall of 1956 105 miles, as far as Creekside, had been completed. By the fall of 1957 planning calls for the line to be completed to Bridge River, a total of 139 miles from the Rosedale terminal for a total mileage of 207 miles of 345-kv transmission.

Again, horizontal configuration is used but this time with lattice type steel towers since they are more readily adaptable to mountainous country. The route of the line is entirely through the Coast Mountain range, passing alongside Harrison Lake, the Lillooet River, Lillooet Lake through Creekside to Bridge River. This is generally the same route as the old Cariboo (sic) Trail, famous in the history of British Columbia; in fact, the transmission line access road incorporates sections of the trail road originally built by the Royal Engineers in 1808.

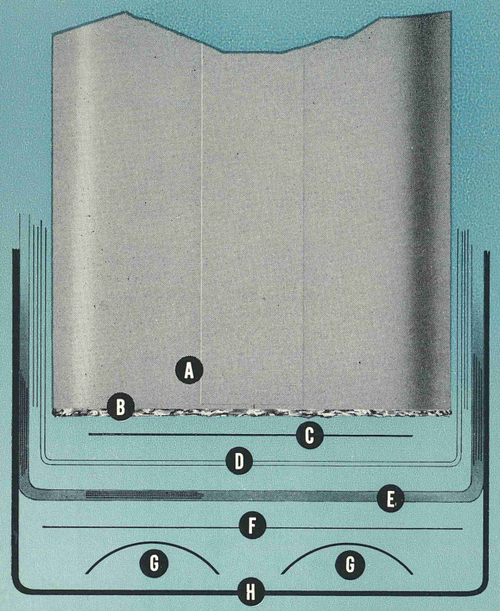
Twin Drake conductors, 795 MCM ACSR were used per phase, the same as on the Ingledow-Rosedale line. Conductor spacing of 18 inches and twenty-one 25,000 pound units per string were used throughout. Many locations required double strings in suspension, due to span lengths and mountainous terrain.

Care was needed in stringing to keep conductor off ground and rocks. Wherever the conductor under stringing tension would rub the ground, lagging was used. Under final tension a two-inch difference of sag between conductors per phase was accepted. Again, inspection of the conductor was made when spacers were installed by the use of an aerial trolley.

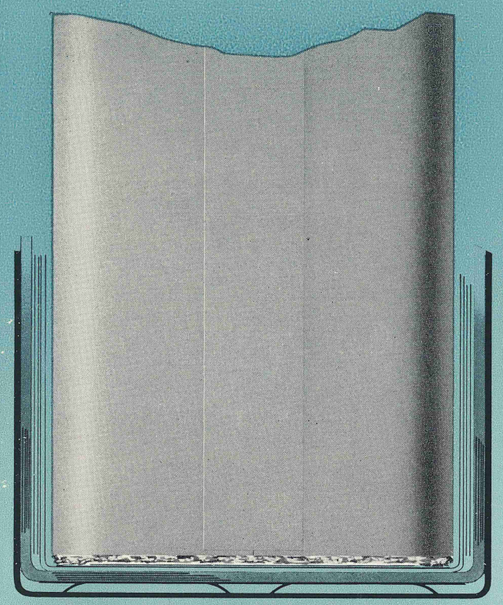
Due to the fact that only six to eight months of each year could be used for construction, a good portion of the conductor will have approximately three years of aging before it is energized at 345-kv.

Part of this line is presently energized at 230-kv as an auxiliary supply to Vancouver in case of the loss of Bridge River No. 1 230-kv line.

ON THE COVER — Ingledow-Wahleach line -- Mast type towers, similar to those used on Swedish 380-kv line, were selected by B. C. Electric for 345-kv Ingledow-Wahleach line.



Looking down on one side of a Varex capacitor: Element is (A); extended foil (B); contact plate (C); element separator (D); pack envelope (E); spring carrier (F); springs (G); and capacitor case (H).



Working through the flexible secondary insulation, the springs press the contact plate firmly against the foil at the end of the element, putting the plate in contact with every layer of foil.

combination of extended foil and spring pressure makes effective electrical contact in Varex capacitors!

The Varex capacitor element is designed with extended foils, one foil extending from each end of the element. Besides reducing hot spot temperature (HI-TENSION NEWS, May, 1957), the extended foil principle is also extremely effective in helping establish an electrical contact system.

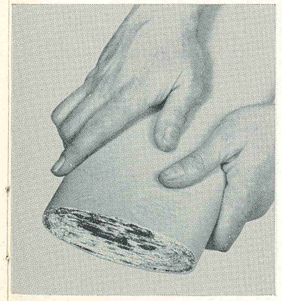
If we look down on a cross section (see illustration above) of the capacitor and move in from one of the narrow sides, we see the steel container, two parallel steel springs, a paper carrier piece for the springs, the multiple-layer pack envelope of capacitor grade tissue, the double-thickness paper element separator, the contact plate, the extended aluminum foil, and the element itself. The four springs (two at each end) are inserted between the metal container and the secondary insulation surrounding the capacitor pack. Their primary purpose is to maintain pressure between the contact plate and the extended aluminum foil. In this way crimped, soldered, or welded connections and inserted tabs are avoided in favor of an electrical contact system maintained by spring pressure.

Four years ago when development of the Varex design began, Ohio Brass engineers considered two basic ways of making contact for introducing current into the elements. One method was inserting contact tabs in the elements. The second method was a spring-pressure contact plate system exerting firm, but low pressure over a large area at the end of the element. This method involved the extended foil principle which had been used successfully for many years by ASEA (Swedish General Electric) whose patents O-B had the rights to use.

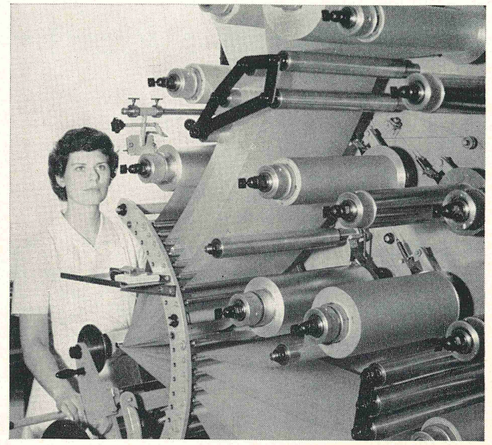
The designers saw several disadvantages in the first method. There were the risks of injuring the dielectric when contacts were inserted, either manually or automatically, and of placing contaminating material in the active dielectric. The thickness of a tab in the space between the two foils would crowd the dielectric and result in higher localized stresses being placed on paper and askarel. Insertions during winding would make it more difficult to control winding tension. Inserting a contact tab in a loosely wound pack could easily result in a poor contact between tab and foil and develop a high current density spot. This could conceivably cause pitting and burning of the foil, and eventual failure of the dielectric.

These considerations led O-B engineers to adopt the extended foil principle for the Varex contact system also. With it, the active dielectric can be continuously wound with controlled tension and without interruption, resulting in a uniform, firm element with no handborne impurities in the active dielectric.

When placed under pressure, the extended foils present a uniform aluminum mat against which the flat contact plates are held under spring-applied load. This construction makes it possible to reduce current density in the foil next to the plate. Each turn of the foil is in contact with the plate, so the current density is more nearly uniform throughout the foils. Maximum current flow distance in the element is about the width of the foil. The combination of low current density and spring pressure assures a sound contact even under high transient current conditions. Since this design eliminates pitting or burning of the foil and since the contact is made outside the active dielectric, there is no risk of damage to the active dielectric.



Using the extended foil principle already proved successful by ASEA (Swedish General Electric), Varex element has a uniform mat of aluminum at each end for making electrical contact with metal plate. This type of contact minimizes current density in the element since the greatest distance current must flow is about the width of the aluminum foil.



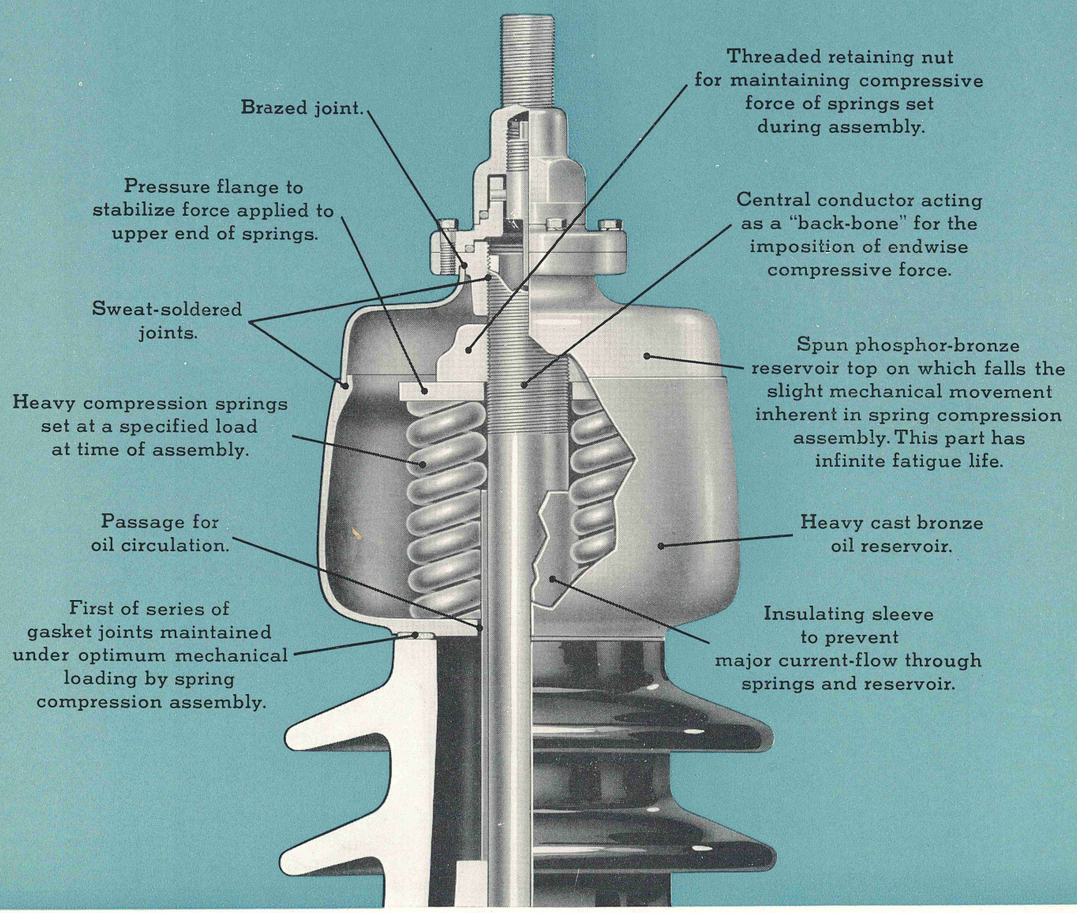
Winding of Varex elements can be done continuously under the same tension since there is no need to interrupt the winding operation to insert contacts. Operator's hands never touch the active dielectric in a Varex element.

The diagram at the beginning of this article shows how the semi-circular steel springs (G) are flattened to give an extra-wide bearing surface against the contact plate and the capacitor element. Note also that the spring edges are placed away from the secondary insulation and against the steel container.

The Varex spring contact system has been carefully engineered. Its effectiveness has been confirmed in electrical testing of both components and finished units, and by inspection of disassembled units. It takes full advantage of the extended foil principle, and is one more good reason for specifying "Varex" on your next capacitor order.

Improved spring compression assembly

well-tried and universally-accepted practice



used in new O-B condenser bushings

refined for longer life and greater reliability

Bushings operate under extremes of temperature, not only those resulting from natural climatic exposure, but also many special conditions induced by heat from the apparatus on which they are mounted. Large masses of porcelain and metal in a bushing create expansion problems in such cases, especially since the two materials react differently and have widely-varying strength.

In order to compensate for thermal effect, all bushings have employed some form of spring compression assembly for the past 25 years, since O-B's invention of the technique. The new O-B condenser bushing adheres to this tradition. Material improvements, however, have been incorporated in the new design. In many respects the bushing and, in turn, the entire power system depends upon the permanence and efficiency of the assembly practice.

Consider a bushing as a stack of several independent parts: metal oil reservoir, mounting flange, and end fittings, porcelain housings, and a series of intervening gaskets. These are held in alignment by powerful endwise compression.

The central conductor forms a natural stress member for such a mechanical system. At one end of the conductor is attached a heavy end plate or fitting that acts as a base for the imposed force. Within the oil reservoir is contained the spring-loading mechanism. The springs bear on the bottom of the reservoir, forcing it downward and transferring this force to successive members.

During assembly of the bushing the compression springs are set by controlled hydraulic pressure to a specified value. While being held in this position, a large retaining nut is run-down on the threaded conductor and locks the established spring pressure for the life of the bushing.

It will be seen that the oil reservoir cover moves when the conductor expands. This phosphor-bronze diaphragm, over the small amplitude of motion, has infinite fatigue action.

Thermal expansion is not the only factor for which spring compression compensates. Over a period of years, gaskets inevitably lose a small amount of their volume. Spring follow-up with the original compressive force renders this condition harmless.

As was stated, earlier designs of the O-B spring compression assembly underwent several improvements when being adapted to the new series of condenser bushings. At one time, the force was exerted by a single massive spring surrounding the conductor. This has been replaced by a nest of four to six parallel springs in the new design. While greatly increasing safety factors, the value of this physical arrangement is in the elimination of a ferrous metal coil surrounding the current path through the central conductor. Under extremely heavy electrical loads, hysteresis and eddy currents were capable of causing heating of the single spring with the possibility of slow, low-temperature annealment. Multiple springs also permit establishment of higher compressive force, therefore, greater rigidity which is desirable in circuit breaker service.

With the removal of one cause for spring heating, a second possibility was then eliminated, namely, any tendency for the springs to carry a portion of the current flowing through the bushing. Surrounding the conductor is a sleeve of fibre insulation which electrically isolates the charged conductor from the bottom of the oil reservoir. In this way there is no important current path which the springs might tend to shunt-out. Any small stray currents are of no consequence. Every means has been taken to exclude the springs from all effects of current-flow.

In considering spring compression assembly, it is obvious that the long, heavy springs used in O-B's new condenser bushing have no practical loss of force over their small amplitude of movement. This force is continuous when thermal contraction occurs, whereas expansion is harmlessly absorbed. The result is permanent tightness of all gasketed joints, without the danger of excessive crushing pressure, and high mechanical strength at all times.

ing of this type for transformer protection only.

O-B manufactures two other 92-kv bushings, Figures 3 and 4. Because they are not recognized in the ASA Standard, they are classified as extra-standard, and "flagged" by shading in the drawings, although they adhere to all standard requirements. These may offer a convenience to some users.

These bushings, Catalog Numbers 45704 and 45703, are identical in basic construction. Put a draw-lead terminal on top, and a corona shield on the bottom, and you have an 800-ampere transformer bushing (No. 45704). Put a fixed conductor terminal on top, and a 'ruptor mounting ring on the bottom and you have a 1200-ampere circiut breaker bushing (No. 45703). Buy one bushing and an extra set of terminals for its opposite application, and you have full dimensional interchangeability.

In case this feature is ruled-out by different BIL's in transformers and circuit breakers, there is still an advantage in using Number 45704 on a 450 kv BIL transformer. Note that Figure 3 and Figure 6 have the same dimensions below the flange. Figure 6 is a 550 kv BIL bushing but can serve temporarily as a replacement until the proper bushing is obtained. This bushing will probably be on hand to protect 1200-ampere circuit breakers, and will require only a set of transformer terminals -- with one exception. Height of Figure 6 is 6 inches greater above the flange. Therefore, the transformer draw-lead will be short by this amount. This is easily handled. Any machinist can duplicate the inner draw-lead terminal with a 6-inch extension, which then merely requires re-brazing. With this part on hand, an ASA Standard 550 kv BIL bushing can substitute for Figure 3.

The economy of lowered BIL in transformers is self-evident, but the ASA Standard makes it perfectly practical to use full-rated bushings in such apparatus. Those who contemplate lowered equipment insulation levels may wish to consider the following group of bushings because of their ease of interchange, economy of emergency stocks, and maximum electrical characteristics.

550-KV BIL INTERCHANGE

Figures 5, 6, 7, 8, and 9 correspond with the ASA Standard table, Lines 3, 4, and 5. Figures 6 and 7, and Figures 8 and 9 are interchangeable bushings. Depending on terminal equipment, only, one can assemble either Figure 6 or 7. They have different Catalog Numbers merely to distinguish one from the other. The same applies to Figures 8 and 9.

Note carefully that Figure 6, for example, could not be converted to Figure 9 merely by changing terminals. "D" dimension of Figure 9 is one inch greater due to higher current rating. See Col. 3 in the table.

Figure 5: This ASA Standard bushing is intended exclusively for transformer use by virtue of oil level, length below flange, and permanent lower end construction that is not convertible. Transformers using this bushing necessitate a spare bushing of this type for replacement.

If circuit breakers are 1200-ampere rating, Figure 6 is the ASA Standard bushing. This fact being declared, Figure 7 is the transformer standard if full dimensional interchangeability is to be obtained. One basic bushing, with proper extra terminal equipment, will protect both kinds of apparatus.

The same is true of Figures 8 and 9 if circuit breakers are rated at 1600 amperes.

Figure 10: This is an extra-standard O-B bushing built to transformer requirements the same as Figure 5. The chief exceptions are the dimensions below the flange. Note that "L" and "W" dimensions correspond with Figures 6 and 7. Therefore, if replacement is necessary, Figure 7 may be substituted. Use of this extra-standard transformer bushing eliminates the need for a special spare transformer type.

PROPER SPECIFICATION

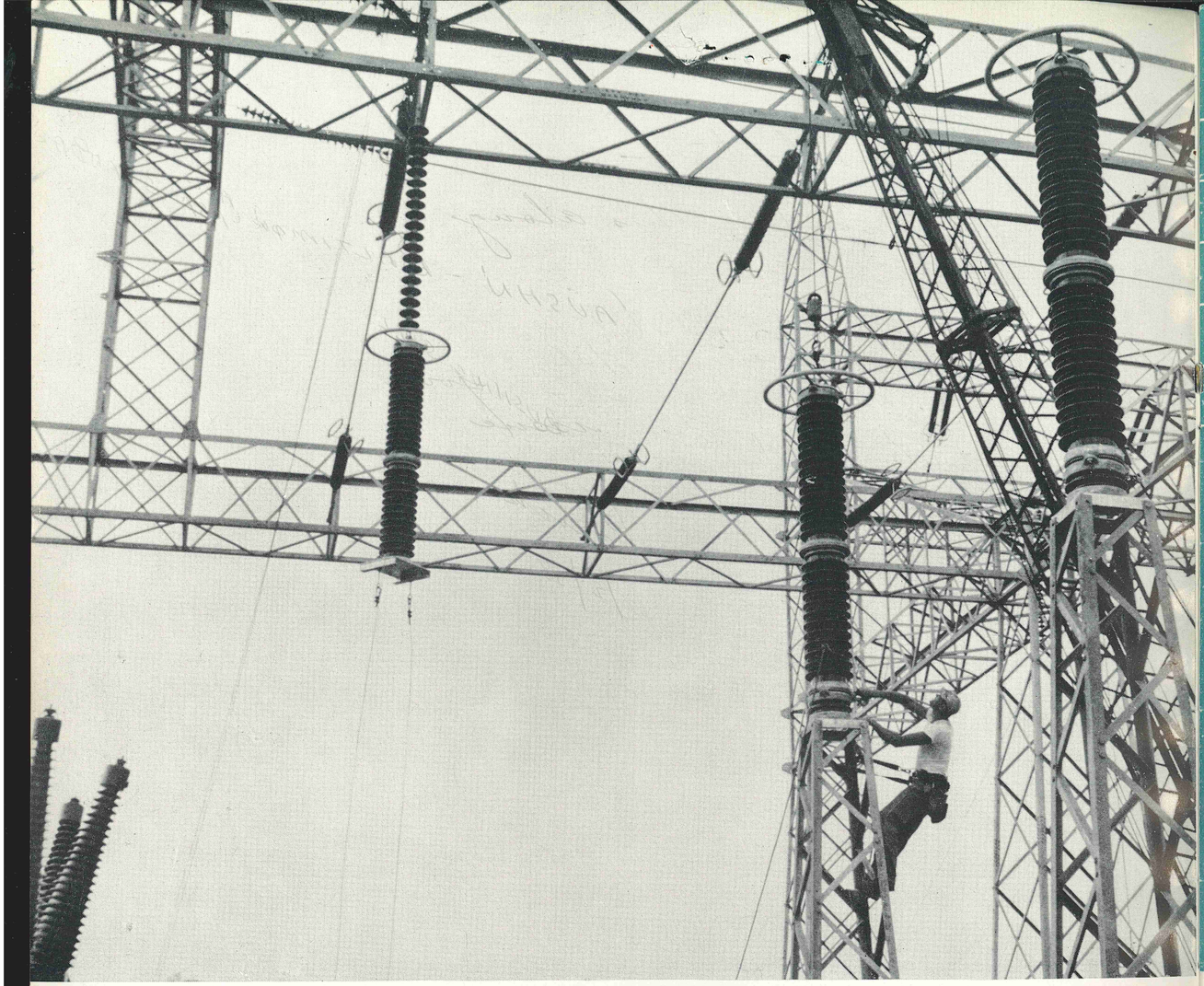
Experience in filling orders for ASA Standard bushings indicates that the best and most foolproof way to specify a bushing is by Line Number in the ASA Standard table. For example, the 550-kv BIL bushing, interchangeable on transformers and 1200-ampere circuit breakers, would be labeled, "ASA Standard C76.1a-1958, Table 4, Line 4." This locates the bushing as to characteristics, regardless of who makes it. Extra-standard O-B bushings discussed here are best identified by Catalog Numbers.

The next voltage class to be considered will be 138 kv.

Volume 27 No. 12 Published by Ohio Brass Company, Mansfield, Ohio 6061-H Printed in U. S. A.

HI-TENSION NEWS

DECEMBER 1958



NO OTHER HIGH VOLTAGE ARRESTER GIVES YOU SUCH CONSTRUCTION CONVENIENCE

FIGURE 1

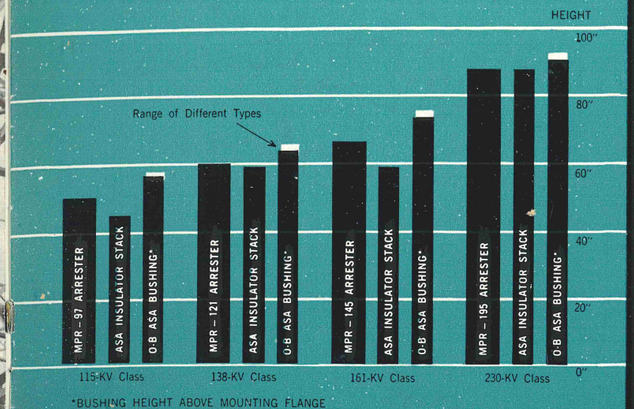
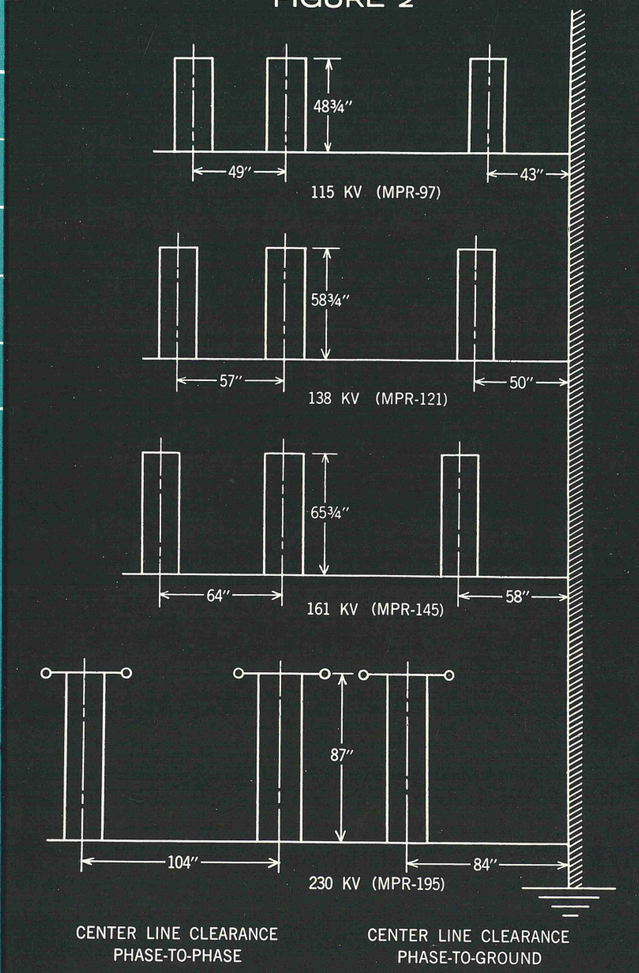


Figure 1 — Relative heights, at four popular voltage classes, of Thorex Type MPR arresters, ASA Standard insulator stacks, and O-B's ASA Standard bushings. Arresters have a diameter of 16¾ inches. Insulator diameter is 17 inches. Arrester net weights are as follows: MPR-97, 414 lbs. MPR-121, 496 lbs. MPR-145, 563 lbs. MPR-195, 817 lbs.

Figure 2—Center-to-center clearances of Thorex arresters in Figure 1. Because only the highest voltage rating shown uses grading rings, considerable space is saved at other levels. Even at 230 kv, the grading ring has a diameter of only 38½ inches. Absence of rings at most voltages, and small size where used, contributes materially to space-saving.

Left—It will be noted in this Thorex installation at 345 kv that one pole is suspended from overhead steelwork while others are supported on conventional fabricated pedestals. Actually, the pedestal-mounted poles serve not only as arresters but also as stabilizers for long jumper loops, thus "doubling" as insulator stacks and saving this added expense.

FIGURE 2



Thorex type MPR . . .
because of its small size
. . . offers many handy
money - saving
applications . . .

We are not going to attempt spelling this out in specific terms. Instead, we merely want to lay a few figures in front of you and let you consider them in the light of your own operation. It has been our experience that different people see the following facts in different ways. Some see economies. Some see construction improvements. Some see convenience. Some see certain station design advantages. Some say, "That looks like a smart trick -- I'll remember it."

Thorex Dynagap Type MPR lightning arresters exploit highly efficient internal elements to gain

Holan moves to top of industry in 10 years

New O-B subsidiary now has plants in three cities

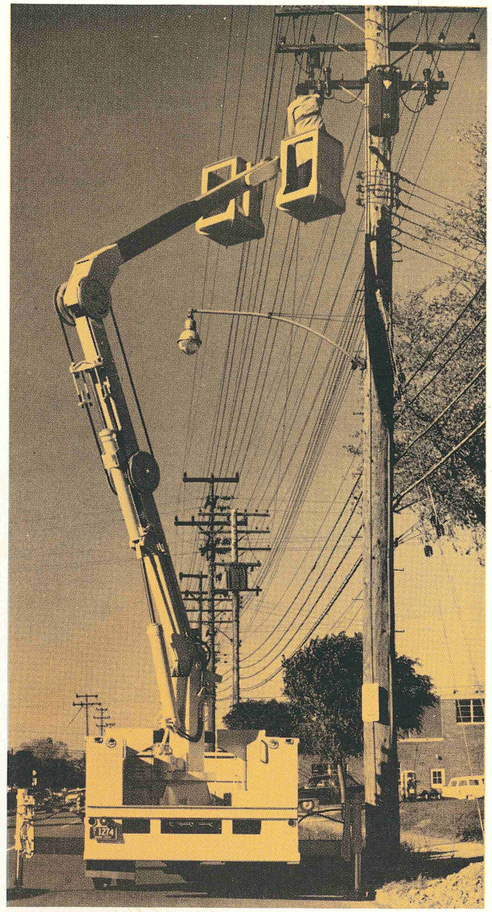
Founded in 1947, J. H. Holan Corporation quickly rose to a position of leadership in quality and engineering. The familiar Holan trademark is found on truck bodies and power equipment used by utilities in both the United States and Canada.

Holan products are now sold and serviced from four locations -- from the main factory in Cleveland, Ohio -- and from Griffin, Georgia; Phoenix, Arizona; and Brantford, Ontario. Total employment is approximately 500.

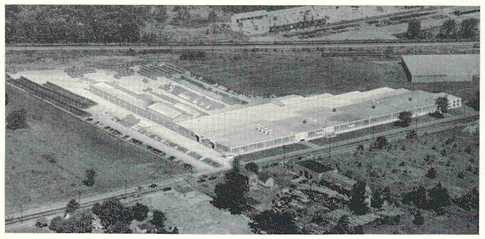
Bodies include line construction and service units, made of tough high-tensile steel or of low carbon steel.

Power equipment includes elbows, heavy and light duty derricks, hydraulic and mechanical ladders, hydraulic (some 3-speed) and mechanical earth borers, power feed attachments, jacks and pole jacks.

On these pages, you see Holan equipment at work -- lifting, digging, getting to hard-to-reach places and safely carrying tools and men. Not shown but already on the Holan drafting boards are other work-simplification devices -- all designed to help you perform utility construction jobs easier -- and better.



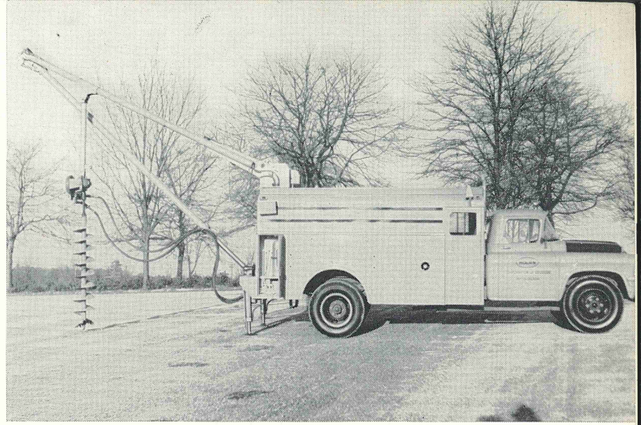
Holan Elbow -- the first aerial elbow with aircraft-type cable controls -- brings new ease of operation, low maintenance and safety to high-up work. Half of upper arm (and sections of the cable controls) are made of fiber-glass-reinforced plastic to provide extra insulation for protection -- the first unit in the industry to offer this as standard equipment.



Cleveland plant has expanded from 20,000 square feet to about 140,000 square feet and is headquarters for engineering. New high bay addition allows inside operation of power equipment.

Holan Corporation of Georgia, Griffin, Ga., manufactures, sells and services Holan units in the south. Other Holan facilities include a branch plant in Phoenix, Ariz., and an affiliate in Brantford, Ont.

Series 6800 Derrick has extra cylinders for extra power in the low ranges. Here, with power feed attachment, it forces digger into tough ground. All equipment is Holan.



Griffin-designed Series 7000 Body is cost-engineered, built of low carbon steel. Series 3700 Derrick, also shown on the cover and below, is the powerhouse of the industry . . . tested at 22,000 pounds, handles 75-foot poles. Digger mounted on side leg for lower stowed clearance and more clearance when setting poles.

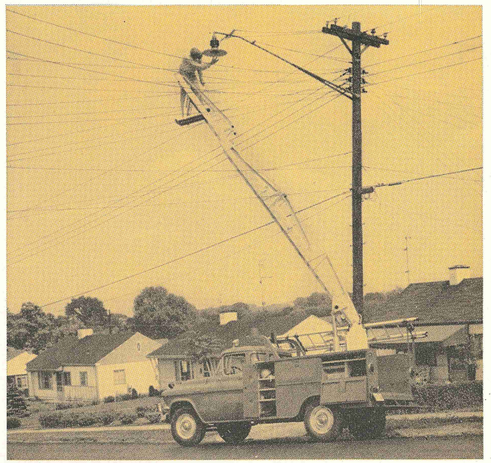
All Holan -- body, derrick, digger, power feed, jacks. Body is rugged CMC-164, made of lighter-but-stronger, rust-resistant high-tensile steel. Self-stowing hydraulic jacks, pioneered by Holan, have 14,000-pound capacity . . . extend in eight seconds, retract in six seconds.

What the Ohio Brass-Holan merger means to customers of both companies

1 The stability of nationwide manufacturing, selling and service facilities.

2 The flexibility of combined engineering resources to produce products designed specifically for utility service.

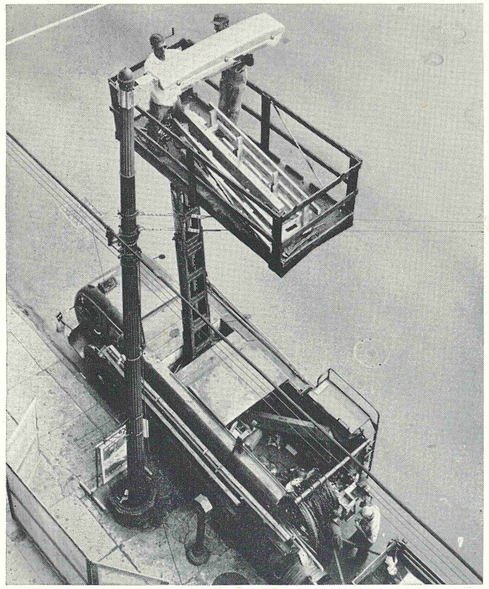
3 The convenience of more personnel and field offices to provide closer contact . . . and faster service to our many good customers throughout the United States and Canada.

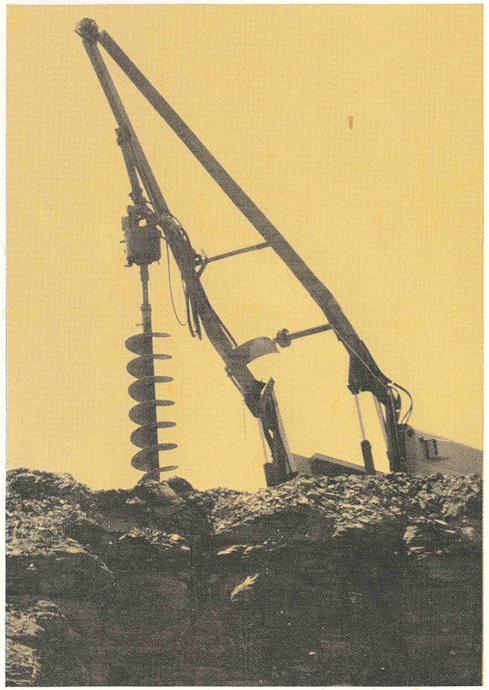


Series 2100 All-Hydraulic Ladder spots a man in the toughest places. Three hydraulic levers for elevation, rotation, and ladder extension and retraction.

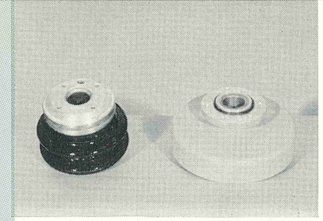
New high-torque, 3-speed earth borer digs through shale and other tough terrain. High torque (maximum 8,000 foot-pounds) means utilities can dig through hard ground, shale and what not . . . also allows use of larger augers. One speed is for hard ground, one for normal conditions, one for spin-off. Positioning cylinder on borer assures straight holes . . . tilts auger for digging anchor holes.

Helping shed new light on downtown area, Holan tower provides 44-square-foot work area for crew members. Rises and goes down with a pushbutton. Safety rails. Hydraulic elevator raises crew and tools from body to platform.

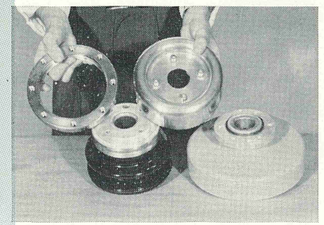




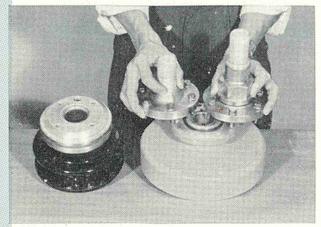
PRINTED IN U.S.A.



1 -- All terminal fittings removed. Lower and upper ends of an O-B interchangeable bushing have the mounting parts shown here permanently attached. Terminals may be changed without admitting air or releasing oil from bushing interior.

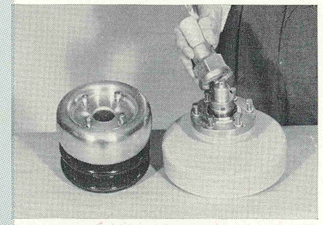


2 -- Optional lower end fittings. Left, circuit breaker attachment ring. Right, corona shield for use when bushing is equipped with draw-lead terminal for transformer service. These two accessories convert the lower end as required. See Standard table, Cols. 7 and 8.

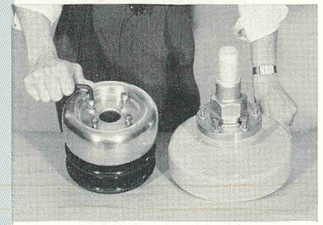


3 -- Optional upper end fittings. Left, fixed-conductor or circuit breaker terminal. Stud has the following thread dimensions: 1½-inch dia. x 2½-inches for 1200 amperes. 2" dia. x 3" for 1600 amperes. See Standard table, Cols. 14, 15, and 16. Right, draw-lead terminal.

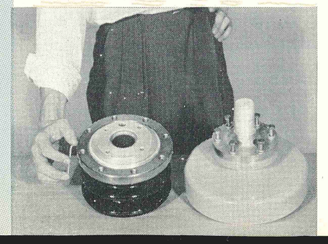
4 -- Transformer top terminal. Draw-lead is brazed to the spade end of the inner terminal and fished through the hollow conductor. Anchor pin is inserted and the outer terminal is then screwed down until O-ring gasket is compressed.



5 -- With inner terminal and anchor pin in place, attachment of the outer terminal completes transformer assembly.



6 -- Corona shield for draw-lead (transformer) service is held to the permanent lower end flange of the bushing by stainless steel hollow-head screws. The terminal combination shown is for transformer application.



7 -- Fixed-conductor top terminal is in place, and the circuit breaker mounting ring has been screwed over the permanent lower end flange. This ring is drilled and threaded to the Standard. Set screws hold the ring in exact position.

interchangeable bushings offer big savings in spare inventory at 115 kv

Because this feature is optional an appreciation of ASA standards is needed to exploit full benefits

EDITOR'S NOTE: As stated in the November issue of Hi-Tension News, it is planned to publish a series of discussions of the ASA Bushing Standard with emphasis on interchangeability. The accompanying article relates to the 115-kv class.

For a better understanding, please have before you the ASA Standard C76.1a-1958, pages 4 and 5, or the November Hi-Tension News which published that material. To interpret the Standard into commercial terms, also see pages 34, 35, 36, and 37 of the O-B Bushing Catalog, publication No. 1354-H.

In the above issue of Hi-Tension News, a return post card was enclosed for readers to obtain additional copies of numbers containing these bushing discussions. Please let us know if you care to have extra copies for your own, or office use.

By a study of some reasonably accurate sketches, properly classified, and a series of pictures illustrating terminal interchange, many readers who regularly deal with bushings will need little or no further detailed discussion of interchangeability. This general subject, however, may have been confusing to some people and to clarify it, some specific cases will be considered.

RATINGS AT 115 KV

It is becoming increasingly common to use reduced BIL's at 115 kv. Full BIL is 550 kv. The lower rating is 450. This will be noted in Col. 2 of the Standards table (ASA C76.1a-1958, Table 4, or November Hi-Tension News, pages 6 and 7). At 450 kv BIL, bushings have a nominal rating of 92 kv, even though they will be used on a 115 kv system. See Col. 1.

Draw-lead transformer bushings have an 800-ampere rating. See Col. 3. This rating is controlled by the current-carrying capacity of the

FIG. 1
ASA STANDARD
Table 4, Line 1
450 kv BIL
800 Ampere
O-B Catalog No. 45701

FIG. 2
ASA STANDARD
Table 4, Line 2
450 kv BIL
800 Ampere
O-B Catalog No. 45702

FIG. 3
O-B EXTRA-STANDARD
450 kv BIL
1200 Ampere
O-B Catalog No. 45704

FIG. 4
O-B EXTRA-STANDARD
450 kv BIL
1200 Ampere
O-B Catalog No. 45703

FIG. 5
ASA STANDARD
Table 4, Line 3
550 kv BIL
800 Ampere
O-B Catalog No. 45708

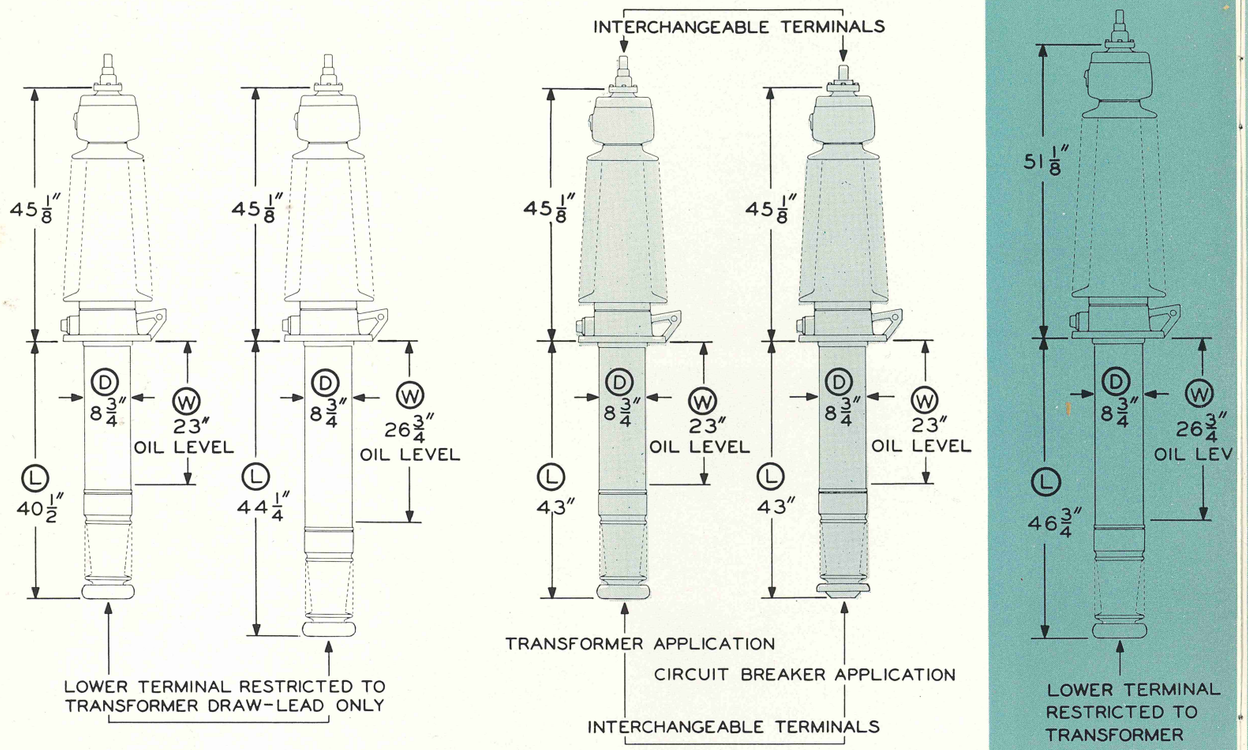


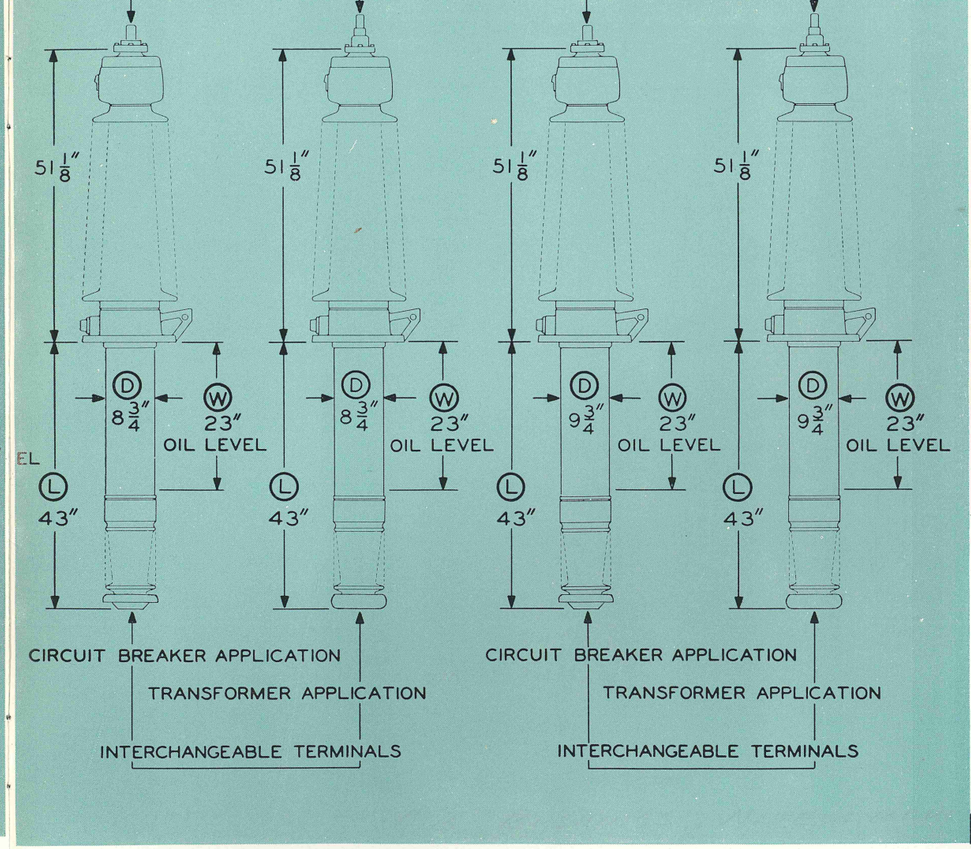
FIG. 6
ASA STANDARD
Table 4, Line 4
550 kv BIL
1200 Ampere
O-B Catalog No. 45709

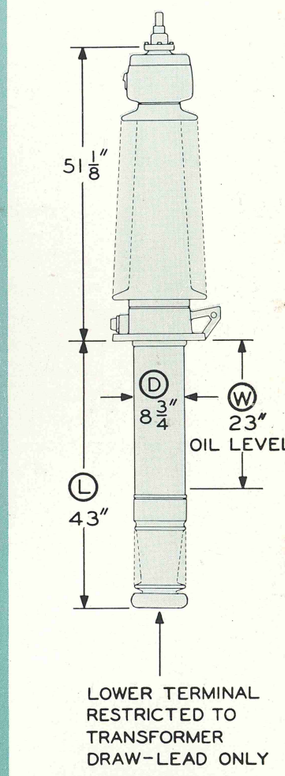
FIG. 7
ASA STANDARD
Table 4, Line 4
550 kv BIL
1200 Ampere
O-B Catalog No. 45710

FIG. 8
ASA STANDARD
Table 4, Line 5
550 kv BIL
1600 Ampere
O-B Catalog No. 45711

FIG. 9
ASA STANDARD
Table 4, Line 5
550 kv BIL
1600 Ampere
O-B Catalog No. 45712

FIG. 10
O-B EXTRA-STANDARD
550 kv BIL
800 Ampere
O-B Catalog No. 45707





draw-lead installed by the apparatus manufacturer. The draw-lead current rating does not refer to the current-carrying capabilities of the tubular bushing conductor which encloses the insulated draw-lead. Because of this, however, transformer bushing terminals are built for 800-ampere service. If terminals are interchanged for application to circuit breakers, and the bushing conductor thus becomes a current-carrying member, the same bushing would go to 1200 or 1600-ampere capacity.

Because of likely applications at reduced BIL, O-B has elected to produce all its ASA Standard and extra-standard bushings with creepage distance one step above nominal ASA rating. Therefore, the 92-kv model has 66-inch creepage distance, and the 115 kv model has, correspondingly, 79-inch creepage -- both one step above minimum standard requirements. This makes reduced apparatus insulation levels still more practical, since surface contamination imposes its own set of operating demands, independent of the economies which may result from lowered apparatus BIL's.

450-KV BIL TRANSFORMER BUSHINGS

If the user elects to apply this bushing, he has the choice between Figures 1 and 2 under the ASA Standard. Both bushings are built specifically for transformer application. Lower end construction is limited to draw-lead service, is permanent, and not interchangeable. Also, the two optional "L" dimensions of 40½ inches and 44¼ inches would not interchange with circuit breakers.

Use of the ASA Standard bushing in 450 kv BIL transformers requires stocking a spare bush-

2—The average span (200 feet) was short.

3—All the poles had been recently re-treated in place with preservatives.

4—Many critical poles had been replaced, and the line had extra guying at critical points.

5—Changes in the National Electrical Safety Code had reduced the transverse loading requirement from eight to four pounds of wind and the rating from a heavy loading district to a medium loading.

Also, in favor of bundling was the availability of an inexpensive device -- the O-B double-eye links (No. 88010) -- to use as a vertical spacer between two suspension clamps.

O-B sales and engineering personnel helped all through the planning and construction stages, making available the experience gained on similar projects at other power companies.

Before reviewing the bundling operation, let's take a brief look at the history of the line. It was built in 1929 for 34.5-kv transmission and insulated with three 11,000-pound ball-and-socket suspension units (O-B 25260) which was more than adequate for the calculated loadings. Seven units were used at deadends and heavy angles. Why the seven units? Thirty years ago, the engineers at The Dayton Power & Light Company recognized the advantage of insulating for anticipated higher voltages.

The higher voltage came in 1940 when the line was raised to 69 kv. By then, 15,000-pound units had become standard so two 15,000-pound units (O-B 32440) were added at suspension points. A 3X #7 Copperweld static wire was installed at the opposite end of the top crossarm from the conductor. Despite the high shielding angle for the top phase, the line had a good performance record with few outages from lightning or any other cause.

That brings us up to the decision of 1958. After almost 30 years of service, the original O-B insulators and hardware were in good condition. More important than their appearance, was the absence of any service failures.

Ordinarily, any company would think twice before basing the success of new investment on materials that had already seen 30 years of service. But considering the performance of the O-B materials and their current condition, it was decided they were good for at least 20 more years and probably more.

The change came in August and September, 1958, when the second 300 MCM copper conductor was added. Installation of the new conductor more than doubled the capacity of the line, lowered the reactance in comparison to providing the same capacity with a single conductor, kept the line out of service for only 10 weeks, for overhead line work, and was done on a low budget.

The O-B links at the suspension points provided an eight-inch vertical spacing between conductors. To get the clearance needed for the extra conductor, the bottom 15,000-pound insulator was removed from the string. Based on Dayton Power & Light operating experience, the remaining four units were considered adequate insulation for 69 kv.

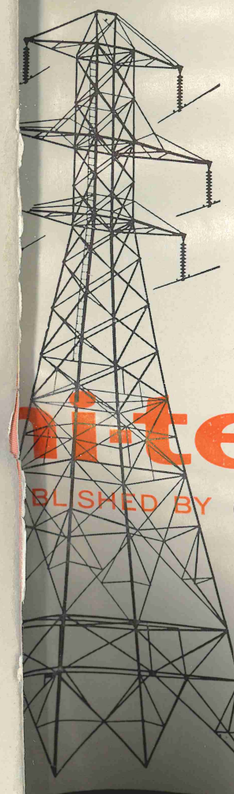
When the insulator was removed, a bolt was inserted in the old suspension clamp and through the top eyes of the double-eye links, replacing the original rivet. (The bolt was needed because of addition of the links.)

Instead of immediately installing a suspension clamp between the lower eyes of the links, a stringing sheave was hung in place and a half-inch rope was threaded through the sheave. The half-inch rope was fastened to an inch rope which in turn was tied to the conductor which was pulled through under a tension of approximately 1400 pounds, maintained by a tension machine. Sagging was done by eye, matching the sag of the new conductor to that of the old.

At the deadends and angles the number of insulators was reduced to five with the 15,000-pound units taken from the suspension points being substituted for the original 11,000-pound units. This was done to gain space for a yoke which could be installed without loosening the original deadend clamp. The yoke plate was fabricated especially for this job by Ohio Brass.

On the 4.9-mile overhead section of the line there are 104 tangent, 12 deadend and 32 angle structures. The average tangent span is approximately 200 feet. The nine-foot-long crossarms are placed on the pole to give a seven-foot spacing between conductors.

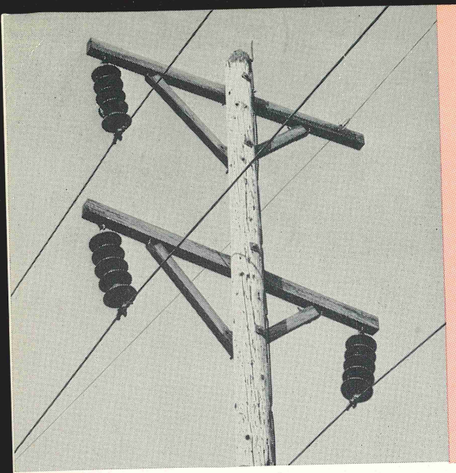
The bundled line went into service Nov. 10, 1958. The Dayton Power & Light Company confidently expects another generation of successful operation.

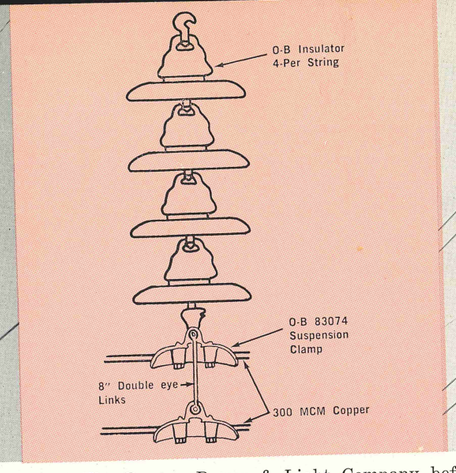


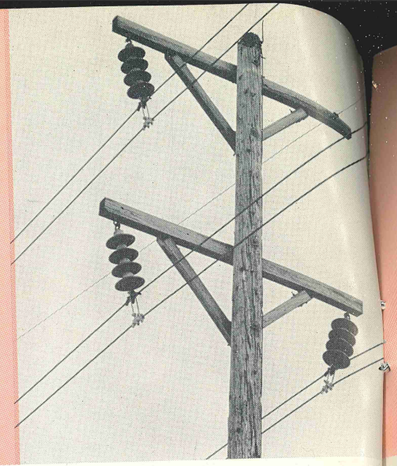
Tension news

PUBLISHED BY OHIO BRASS COMPANY, MANSFIELD, OHIO VOL. 28, No. 3

MARCH 1959

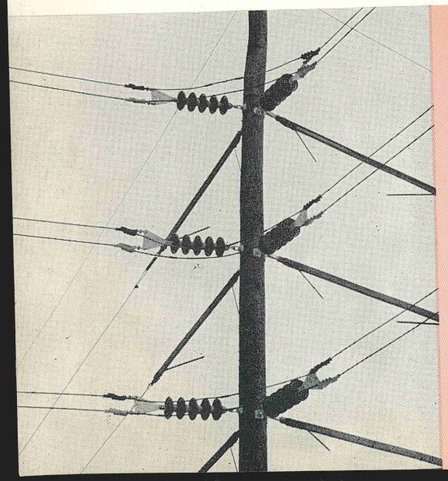




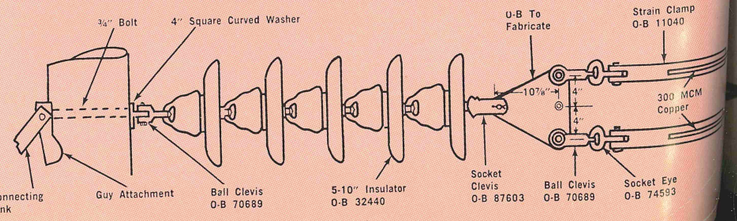


Tangent poles at The Dayton Power & Light Company before and after bundling. One insulator was removed to provide clearance for second conductor. Drawing shows detail of modification.

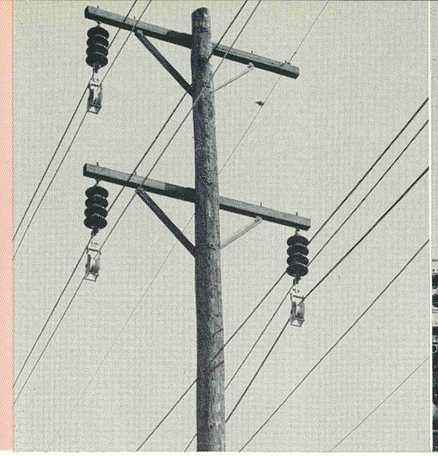
DAYTON POWER AND LIGHT USES BUNDLED CONDUCTOR AT 69 KV



At deadends the number of insulators was reduced to five 15,000-pound units from seven 11,000-pound units. Special yoke plates (shown in drawing) were used to maintain the same approximate spacing between pole and clamps.



Stringing of second conductor is done under approximately 1400 pounds tension. Stringing sheaves hang from extension links.



extra strength in original line makes practical addition of second conductor to increase line capacity

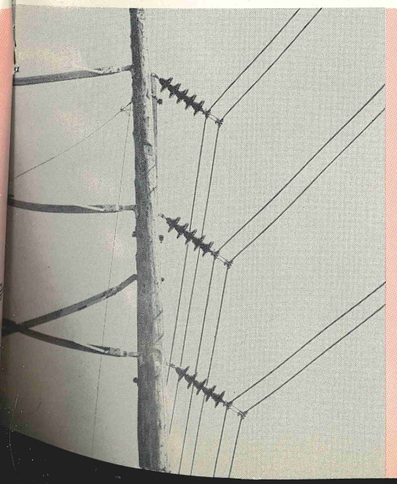
To bundle or to reconductor. That was the question which faced The Dayton Power & Light Company when it needed to increase capability on sections of its 69-kv transmission system.

Two new 130,000-kw generating units were due to go in service at F. M. Tait station. Two 69-kv lines run from Tait to Overlook substation -- part of two transmission loops that supply the central Dayton area. The decision on the outer line was easy. It had 2/0 copper conductor which was not practical for the increased load. The line was rebuilt with 1,351.5 MCM all-aluminum.

But the story was different on the second line. This 5.59-mile-long (4.9 miles overhead, .69 miles underground) line had been built in 1929 with 300 MCM copper conductor for 34.5-kv transmission. Several possible ways were considered for raising its capacity.

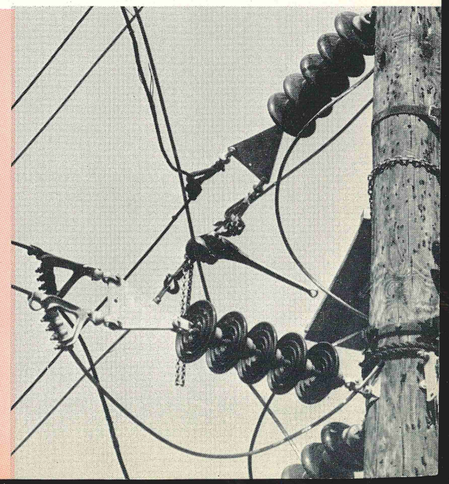
The desire for economy led to a thorough study of using a two-conductor bundle, adding a second conductor and saving the existing conductor, hardware and insulators. At the start of their study, Dayton Power & Light engineers realized that seldom can existing lines be bundled without encroaching on the safety factor. Only under unusual circumstances is bundling the answer.

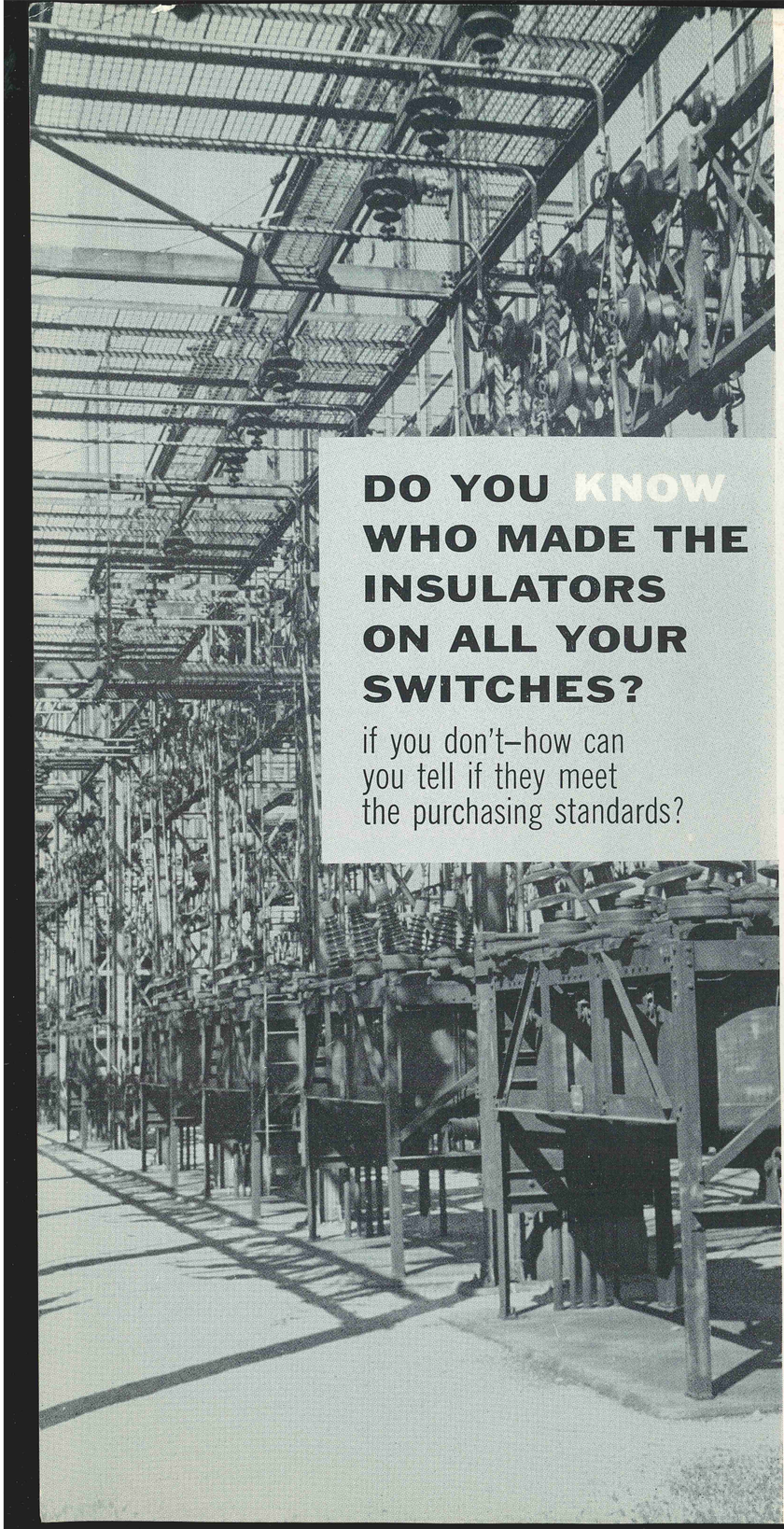
Fortunately, the situation on the Tait-Overlook line indicated bundling would be a good solution: 1—The line had been built over-strength originally.



At critical points, like this angle pole, Tait-Overlook line has new poles. Extra guying also made line over-strength for single conductor.

Construction at deadends was with O-B hook bolt strain clamps (No. 11541). Note that tackle loop has been added to clamp (lower clamp) since original line was built.





DO YOU KNOW WHO MADE THE INSULATORS ON ALL YOUR SWITCHES?

if you don't–how can you tell if they meet the purchasing standards?

Buyers of station equipment, especially switches, are occasionally offended when we say they don't know what they are getting. The offense is not intended, but the fact merits an open-minded approach.

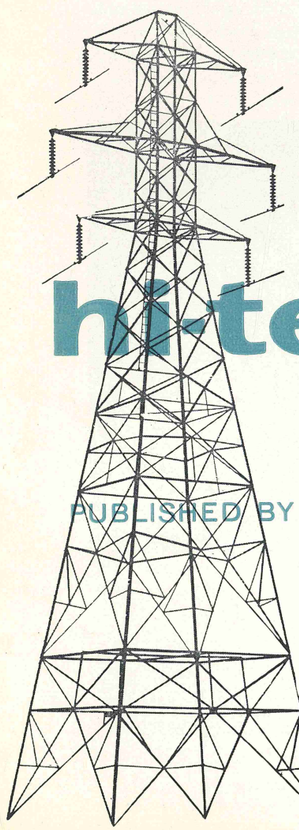
Most power companies have a list of acceptable insulator suppliers. Usually this list is not very large — it comprises a few manufacturers whose products have performed satisfactorily on that system, and whose reputations are above reproach. The average buyer will declare that every insulator on his system has been bought in accordance with such a list. (Every insulator except a few thousand in vital locations — perhaps).

Switchgear manufacturers can obtain their insulators from many sources of supply. This is a perfectly natural procedure. In the absence of any expressed preference for make of insulation, the switchgear manufacturer is powerless to perform a piece of service which he is both able and willing to render.

When the make of insulation is not specified on switchgear orders, the door is wide open for thousands of insulators of unknown name and, therefore, unknown quality to find their way into a power company's stations. Such insulators have the double duty of both mechanical and electrical integrity. Ideally, the astute buyer would prefer that they should be better than average since there is no cost penalty. What assurance is there that only the best will be supplied when normal buying standards are not applied in their purchase by means of an expressed preference to the equipment manufacturer.

The remedy for this is extremely simple. Just ask for the insulator you want! Because of the proved service and lifetime reputation of the O-B switch insulator, you couldn't make a better choice. Name it, and you can have it.

6120-H Printed in U. S. A.



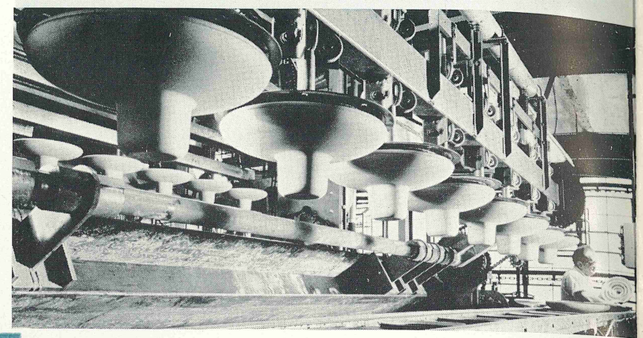
hi-tension news

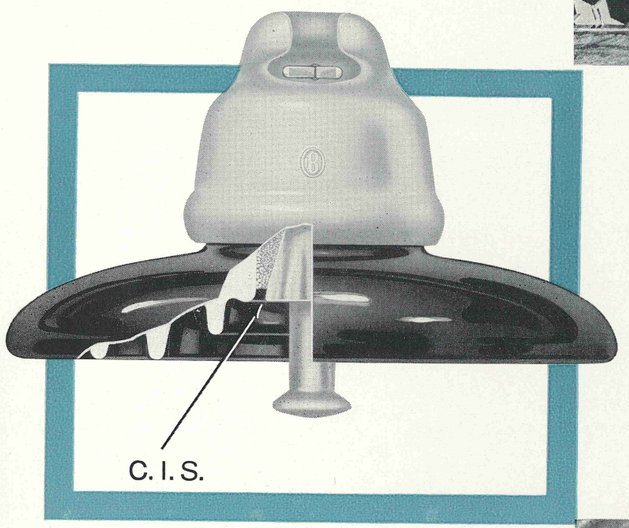
PUBLISHED BY OHIO BRASS COMPANY, MANSFIELD, OHIO Vol. 28 No. 11

NOVEMBER 1959

GOLDEN ANNIVERSARY 1909 1959 MODERN SUSPENSION INSULATION

Unusually high degree of quality control and product uniformity have been achieved in the automated Futura production line. Here unfinished pieces are gently transferred (by vacuum gripping devices) from one production line to another.





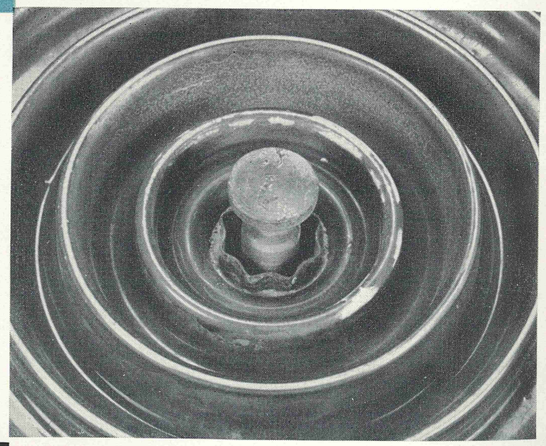
improved in

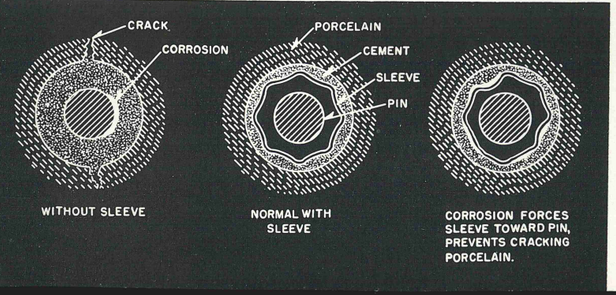
every respect...

and built to stay that way!

O-B FUTURA

A prototype of the Futura insulator with the Corrosion Intercepting Sleeve (C.I.S.) served 15 years where conventional units had cracked in one to five years. Tested after 15 years, the unit was completely sound mechanically and electrically and could be expected to give many more years of service.





Schematic drawing shows how Corrosion Intercepting Sleeve (C.I.S.) on Futura insulators acts to protect porcelain from stress which would crack ordinary insulators.

The present advantages of O-B Futura insulators are not likely to be overlooked by the utility engineer.

Futura's higher strength and lighter weight, its improved resistance to impact and handling shocks on porcelain and pin, its increased puncture strength on 60-cycle and impulse test — these and other advantages deliver an immediate return on every dollar invested in suspension insulators.

In our opinion, however, the true significance of Futura's superior characteristics lies in the fact that they were built into this insulator for keeps!

We're referring, of course, to Futura's Corrosion Intercepting Sleeve (C.I.S.) — the protective device that has kept prototypes of this unique new insulator "alive and healthy" for 15 years (to date) in locations where conventional designs are failing in one to five years.

INSULATORS

Previous articles (July, August, September 1959) have discussed in some detail the forms of corrosion to which all suspension insulators, by the very requirements of their design, are most susceptible.

HOW CORROSION FAILURE OCCURS

Among these, the most efficient, most insidious destroyer of suspension insulators is the oxygen concentration cell, which produces iron rust (chiefly magnetic iron oxide) around the insulator pin just below the surface of the cement line.

This common form of corrosion is "efficient" because the oxide crystals it produces (almost continuously, once started) are at least 52 per cent larger in volume than the original metal of the pin and almost as hard as cast iron — creating an expansive force before which the adjacent material must yield.

It's insidious because cracks which develop in the porcelain insulator shell may be tight enough to escape detection for some time. Half the insulators in a string may be cracked, and therefore electrically unsound, with no external evidence of any damage.

Until the present time, fortunately, this form of corrosion failure has been a common occurrence only in a relatively few areas where heavy atmospheric contamination — and a little moisture — have combined to produce the conditions under which the oxygen concentration cell thrives.

In the future, however, these ideal conditions for corrosion failure can be expected, almost inevitably, to develop in many areas not presently afflicted — and the development of these ideal conditions will be significantly hastened by the present trend toward higher transmission voltages.

EFFECTS OF ATMOSPHERIC CONTAMINATION, HIGHER VOLTAGES

As pointed out in the articles referred to earlier, the progress of corrosion is greatly accelerated by the presence of ozone, which is a much stronger oxidizing agent than oxygen itself. Ozone, for example, will attack even mercury and silver, which oxygen does not affect. And since water will absorb 44 times as much ozone as oxygen, the former is carried much more effectively by moisture in the air.

Atmospheric contamination accelerates corrosion because it accelerates the generation of ozone. As reported in a 1958 ASTM paper, the hydrocarbon and nitric acid found in the atmosphere of Los Angeles produce nearly 2000 tons of ozone every day!

And widely published studies have shown that ozone concentration is rising in all areas of the country — especially in urban and industrial areas, where more atmospheric contaminants are produced.

While atmospheric contamination thus plays a major role in corrosion, higher transmission voltages play a similar role in supplying the oxygen concentration cell with an abundant supply of oxygen heavy ozone.

This occurs as a result of corona discharges, which produce ozone in the air around the insulators.

A dry, clean insulator string will not go into vigorous corona until far above its operating voltage. When insulators have accumulated a layer of airborne contamination, however, a slight drop in temperature in humid weather will form a film of moisture over the insulator, release conductive salts in the layers of airborne contamination, and increase leakage currents, which almost always result in electrical discharges in the air.

The ozone and the moisture are quickly dissipated in open air, but the sheltered position of the suspension insulator pin traps these elements where the damage is done — above the cement line of the pin.

HOW FUTURA "INTERCEPTS" CORROSION

Futura's Corrosion Intercepting Sleeve (C.I.S.) doesn't stop corrosion. There are ways to stop it, of course, and methods involving the use of corrosion resistant alloys have their place, although they represent a rather expensive solution.

Instead of using high cost alloys to *stop* corrosion, O-B engineers used standard metals — and a little ingenuity — to render it harmless.

The Corrosion Intercepting Sleeve shown in the accompanying pictures is designed to yield under the expansive forces set up by corrosion products between cement and pin. The action of the sleeve thus relieves stress as it builds up, and the porcelain itself remains unaffected.

The soundness of this design, as already mentioned, has been proven by the 15 years of service rendered to date by prototype Futura insulators at locations where ordinary insulators have regularly failed in one to five years.

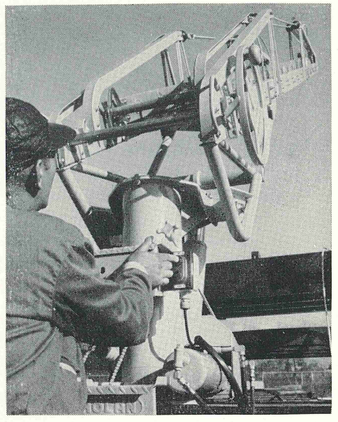
That's why we say of Futura C.I.S. suspension insulators, "improved in every respect — and *built to stay that way!*"

GET UP IN THE WORLD

on a Holan Aerial Ladder

Pushbutton control is an important operating feature of the Series 2600 Manually-Operated Hydraulic Ladder. The fly ladder is extended and retracted with a windlass; a crank rotates the ladder 360° in either direction.

The three levers shown on the right side of the pedestal control elevation, rotation, extension and retraction of the Holan 2100 Hydraulic Ladder. The 2100 rotates 360°, elevates to 75° and reaches up to a 40-foot platform height.



Finding the best way to get "way" up in the air is a problem faced by most utility construction and maintenance crews.

Aware of the demanding safety and efficiency standards required of off-the-ground equipment, engineers of the Holan Corporation have developed a complete line of manual, mechanical and hydraulic aerial ladders.

Popular with street light maintenance and light repair crews is the inexpensive, two-section Model 1520. The ladder can be locked in one forward position and five positions to the right side. The 1520 is available in ground-to-platform heights of 19, 21, 23, or 25 feet.

Light in weight and exceptionally well balanced, the 1520 ladder is stored overhead, leaving the service body clear for other work. One man can operate the Model 1520.

Elevation, rotation, extension and retraction — every move of the Holan Series 2100 Hydraulic Ladder — is hydraulically controlled. It rotates a full 360°, elevates to a 75° angle and reaches up to a 40-foot platform height. Holan offers the Series 2100 in four models — 27-foot, 31-foot, 35-foot and 40-foot ground-to-platform heights.

The 2100 is available with either power takeoff or engine driven hydraulic systems. Three levers mounted on the pedestal control all movements. A control valve with built-in relief valve and check valves provides smooth throttling and locks the ladder in position.

An optional duo-level platform provides comfortable standing surfaces for high or low ladder angles.

Because of hydraulic help, the Series 2500 manually-operated Hydraulic Ladder offers some of the benefits of a fully-hydraulic ladder at a price close to that of a mechanical ladder.

By moving the pump handle back and forth, the 2500 can be quickly and easily raised. It can be spotted in an infinite number of positions, the angle of elevation can be changed while the fly section is fully extended, and the ladder is automatically lowered by turning a valve handle. Several efficiency and safety features — plus the hydraulic elevation — make the Series 2500 a desirable aerial ladder.

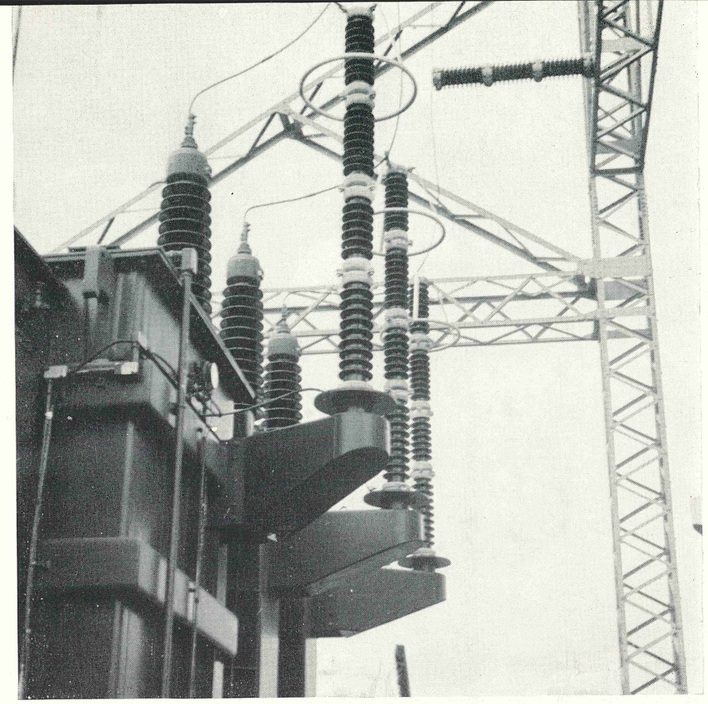
Pushbutton controls are featured on the Series 2600 Manual-Hydraulic Ladder. The 2600 is raised and lowered by pushing buttons on the control station at the mast. If desired, a remote pushbutton control station can be located on the upper right side rail.

A needle valve with an extended handle provides the accuracy needed for precise spotting. The ladder can be rotated 360° with a crank directly behind the ladder. Crank location allows a better view for spotting, avoids left-hand cranking and gives maximum clearance between body wall and ladder.

A windlass, operated from the right side, is used to extend and retract the fly ladder of the 2600.

Numerous optional features — including fiberglass-coated side rails — are offered on Holan aerial ladders. Check your Holan Field Representative — or write Holan Corporation, 4100 West 150th Street, Cleveland 35, Ohio — for more complete information on aerial ladders. Holan Corporation is a wholly-owned subsidiary of The Ohio Brass Company.

This transformer, and its substation, serves a sizeable urban community as well as a rural and scattered industrial load. While service continuity and equipment protection are both important, an effort was made to economize in construction. Such factors apply to thousands of primary substations throughout the country.



ONLY FOUR YEARS AGO YOU PAID A PREMIUM FOR THIS PROTECTION

Modern intermediate class Thorex Arrester approximates recent station class...except in cost

"Is the protection afforded by an Intermediate Class lightning arrester good enough for my purpose?", is a question often asked. In the case of the Thorex Dynagap arrester, this question has a straight answer.

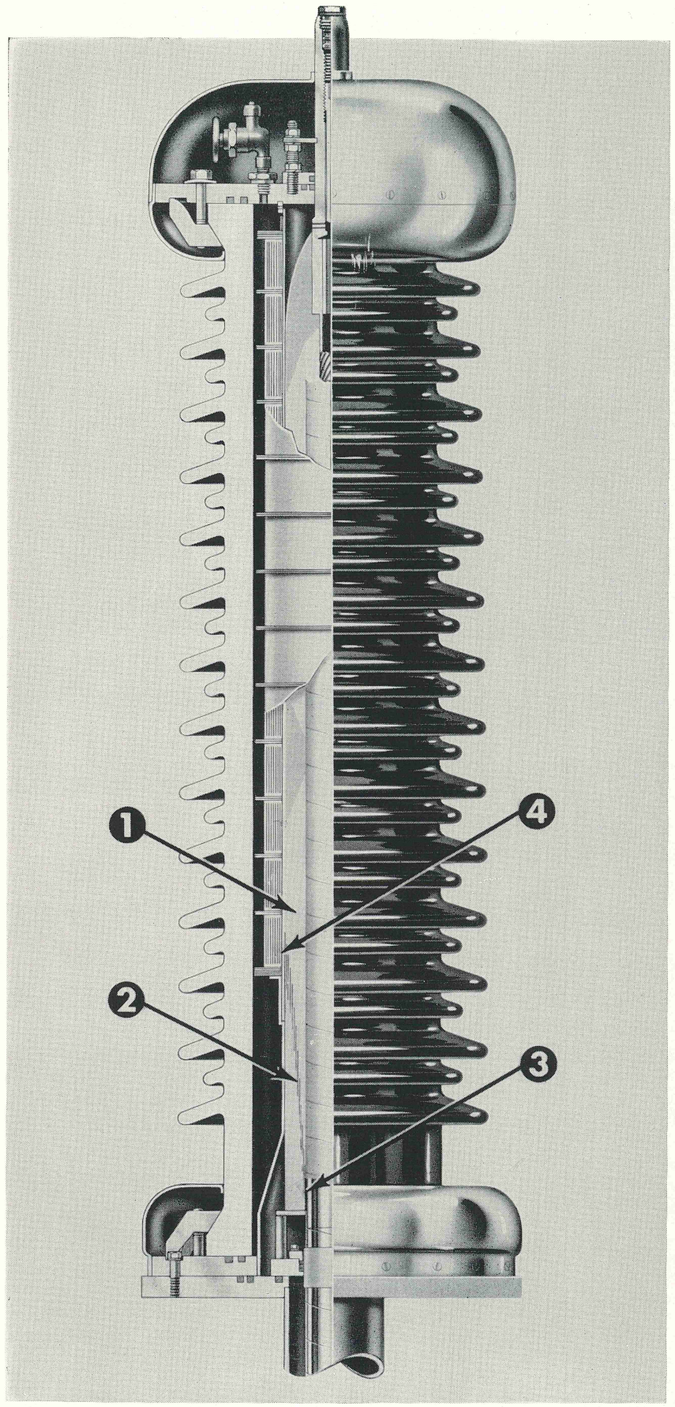
For example, we will take a typical arrester rated at 60 kv line-to-ground, and normally used in 69-kv service. In the O-B catalog published August 1955, a *Thorex Station Class* arrester of superior characteristics for that time had 163 kv maximum IR discharge voltage at 5,000 amperes. Now, less than five years later, the Thorex *Intermediate Class* arrester has 165 kv under comparable conditions — for all practical purposes, the same!

While no one can afford to look too far backward in the electrical industry today for comparisons, it is significant that a modern Thorex Intermediate Class arrester matches the protection afforded by a four-year-old Station Class, and vastly exceeds it in the all-important category of durability.

These comparisons have been made within the Thorex line which has always offered exceptionally high protective characteristics. Were they made with arresters of lesser, and more conventional protective levels, the present Thorex Intermediate Class would show to even better advantage.

Adding one more fact, current models of Thorex Type GP Intermediate Class lightning arresters exceed by a considerable margin most other significant ASA Standard requirements for Station Class.

Review the matter of arrester application with your O-B representative. He may be able to guide you in a program of efficient equipment protection on a low budget.



Imbedded in the lower paper build-up (1) is the helical foil ribbon (2) which generates the stress cone. This contacts the grounded outer shielding tape of the cable (3) and is coupled with the ground plate of the first grading capacitor (4). Owing to the multiple turns of paper in the build-up, individual coils of the stress cone have no appreciable stepped relation, such as shown in these schematic illustrations. The outward flaring curve of the cone is smoothly formed to an exact logarithmic shape.

Unique principle of Stress Cone in O-B Potheads contributes to excellent grading

ingenious design now allows this vital element to be completely factory-manufactured

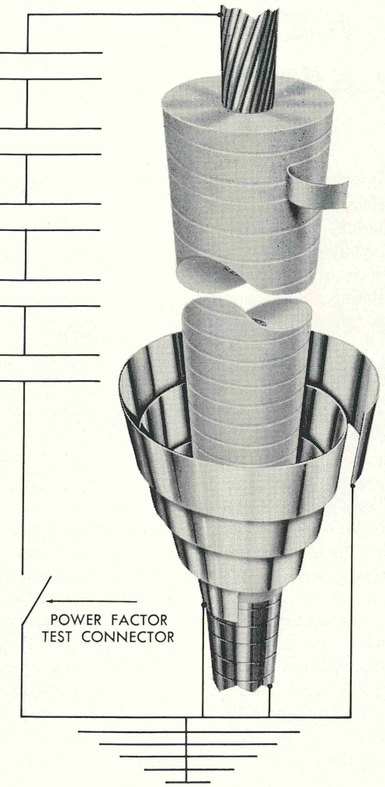
What might appear to be a simple element in high voltage pothead design — the stress cone — has always presented a serious problem to development engineers. The sheath of an underground cable constitutes a cylindrical ground plane that cannot be terminated abruptly. Therefore, the first step in stress relief is to insert more radial distance between the sheath and the conductor by a process of flaring-out ground potential by some form of stress cone. Shape of this cone has been carefully calculated to keep longitudinal stresses at an acceptable level but, formerly, this was a field operation which, to be practical, admitted many compromises.

O-B's new capacitor graded pothead now permits stress cone construction to become a precision factory operation. This is one unique part of its design. At the point where the grounded cable sheath terminates, the stress cone and build-up are applied as a unit in the field. This is in contrast to the conventional stress cone and build-up which are applied separately. These elements in the new O-B pothead are factory-wound to assure correct contour of the stress cone. Under conventional practice, extreme care is required to prepare and apply the stress cone as a field procedure. Today, this entire operation is performed on the O-B pothead merely by slipping the prepared build-up over the cable, and tightening it with a few turns.

At the lower end of the build-up, a continuous ribbon of foil is applied to the surface of the paper at a varying angle. Wrapping produces a helical shape of this ribbon, and its angle of mounting on the build-up controls its flared conformation. Both ends of the foil are at ground potential. Its smaller diameter is in contact with the grounded shielding tape of the cable, and its outer diameter is likewise brought to ground. The capacitor stack is grounded through the power factor test connector to facilitate field inspection. These connections are shown in the schematic stress cone illustration.

Almost the total length of the O-B pothead is included in the capacitor grading system. This produces an exceptionally long, smooth voltage gradient heretofore not attained in pothead manufacture. In order to exploit this good design, however, the stress cone itself must have correct electrical properties since it is a part of the grading circuit. O-B's unique and ingenious stress cone principle fully meets this requirement.

O-B capacitor graded potheads are manufactured for all high and low pressure oil filled cables, and gas filled types. Their present range is from 115 to 230 kv, inclusive. Other voltages will soon be included in the series. If your future plans involve underground cable systems, do not fail to investigate this highly advanced terminal equipment.



Detailed schematic view of the O-B stress cone. One end of the foil ribbon contacts the grounded outer shielding tape of the cable. The other end couples with the ground plate of the first grading capacitor. This ribbon is attached to one face of the build-up paper which is omitted in this illustration. The many turns of foil in the actual stress cone produce a smooth, helical shape without appreciable steps.

for fast,
economical
distribution
deadends...

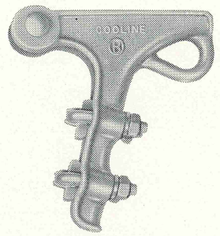
CHOOSE ONE OF THESE THREE NEW O-B CLAMPS

Regardless of your preferences in deadend construction, there's an O-B clamp to fill your needs.

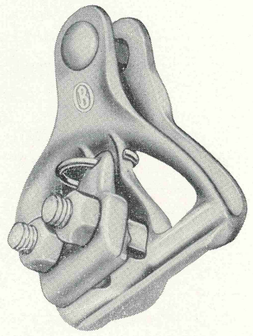
The newest three of the many clamps in the lineup offer some special advantages for your consideration.

You may be interested in the ease of hot working that was a prime consideration in developing the Strateline design. Or the bonus on holding strength offered in the Cooline-LW. Then there's extra convenience that was built into the 88500 Universal Clamp by the addition of a spring which holds the clamp open while the jumper loop is being formed.

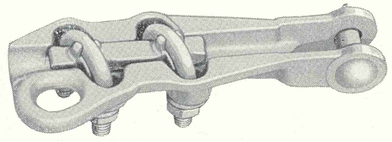
Here's a brief rundown on the advantages of each clamp. You'll find other O-B distribution clamps featured in Catalog 33 and Bulletin 1396-H. All are O-B distribution materials available locally from your Graybar warehouse.



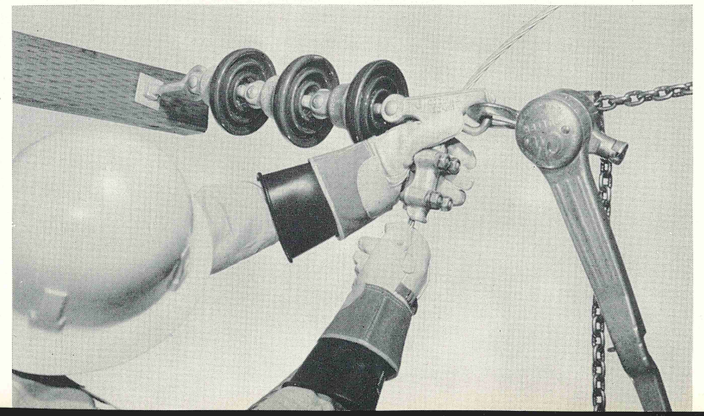
Cooline L-W Clamp — An aluminum quadrant style clamp that provides transmission quality at distribution prices. Especially designed for the trend to larger conductors and shorter spans. Nevertheless, the clamp has more than adequate holding strength for distribution and station deadends and for many transmission deadends... 10,000 pounds for the two U-bolt clamps, 15,000 pounds for the three U-bolt model. Takes wide range of conductor sizes (.20 to 1.3 inches).



88500 Universal Clamp — Made of galvanized malleable iron to assure high resistance to corrosion. Features spring on keeper-piece to hold clamp open automatically while jumper loop is formed and conductor positioned. Has ultimate strength of 10,000 pounds and more than adequate holding strength. Takes conductor from .20 to .50 inches in diameter.



Strateline Clamp — Especially convenient for use in hot-line work since slim design can be quickly covered with rubber goods. Keeper-piece is permanently attached to U-bolts which are extra-long to permit positioning conductor without removing bolts. As with all O-B clamps, nuts and U-bolts are rounded. Available in aluminum, malleable iron and bronze.



Cooline L-W Clamp — Has holding strength equivalent to more than 90 per cent of the conductor strength, costs 40 per cent less than regular aluminum or malleable iron quadrant clamps.

50 YEARS AND 50,000,000 INSULATORS LATER

First shipment of O-B Futura insulators leaves Barberton plant on September 11

In 1909, just half a century ago, Ohio Brass shipped the first successful, one-piece porcelain, cap-and-pin suspension insulator — the basic O-B design still followed today in all cap-and-pin insulators.

That first shipment was used on the 110-kv line from Niagara Falls to Toronto, built by the Hydro-Electric Power Commission of Ontario.

On September 11, 1959 — 50 years and 50,000,000 O-B suspension insulators later — we made another shipment of equal significance: the first O-B Futura C.I.S. suspension insulators.

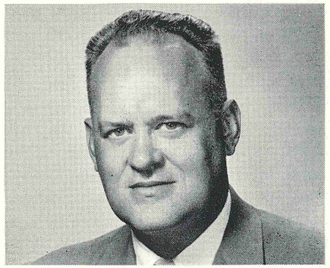
They went to Iowa Southern Utilities Company at Centerville, Iowa, for use on the Burlington - U. S. Gypsum Co. line.

Shown examining the Futura units in this shipment are H. D. Pritchard, foreman, and A. D. Lantz, development engineer.

Paul Ross Succeeds Wade Burleson as Manager of O-B Power Utilities Dept.

Burleson becomes consultant on extra-high voltage projects

Wade H. Burleson



Paul M. Ross

Wade H. Burleson, manager of the O-B Power Utilities Department since 1937, has been appointed consultant to the General Sales Department on extra-high voltage transmission projects.

Succeeding him as manager is Paul M. Ross, who has been with Ohio Brass for the past 25 years. His most recent position was manager of the Equipment division.

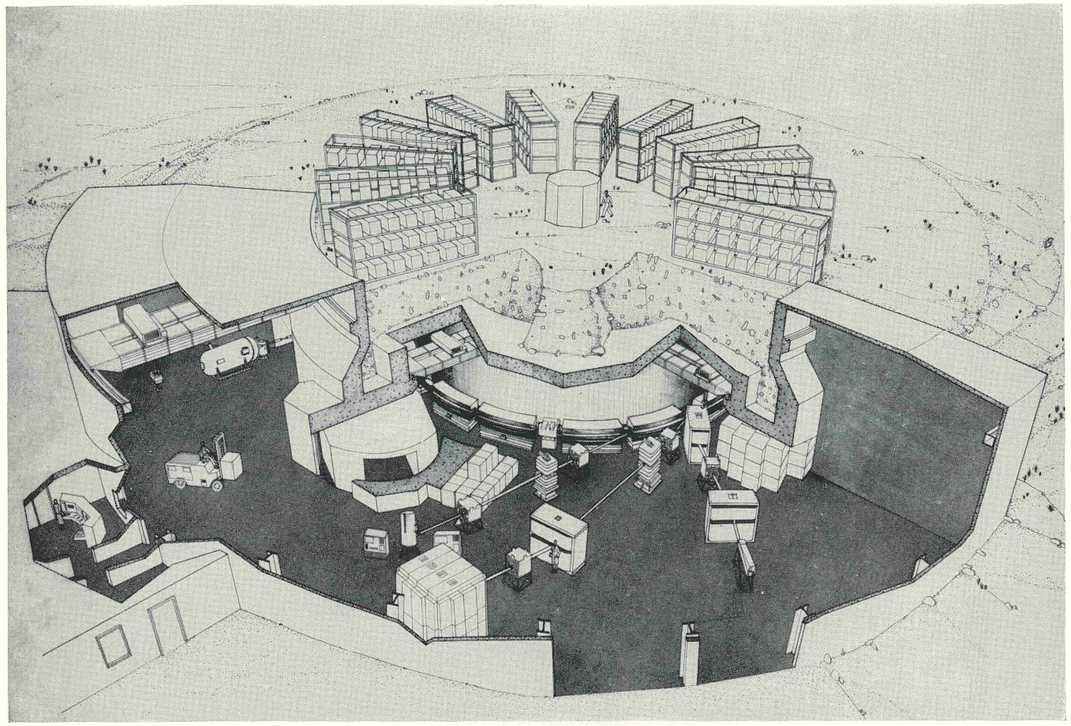
Wade came to O-B as a sales engineer in 1922. Before that time, he was Chief Electrical Engineer for Texas Power and Light Co. After six years in the O-B sales offices at Birmingham and Kansas City, he returned to the Mansfield office in 1928. He subsequently became Manager of the department and, in 1940, a Director of Ohio Brass Company.

Wade was elected to the Board of Governors of NEMA in 1953 and is well known throughout the electric utility industry for his work in this organization, in AIEE, and in many other professional associations.

Paul Ross is also well known in the electric utility industry for his active participation in NEMA and AIEE.

Paul joined Ohio Brass in 1934 as engineer assistant in the O-B High-Voltage Laboratory, becoming supervisor of the High-Voltage laboratory in 1937. He became associated with the Power Utilities Department in 1947 and later became Manager of the Transmission and Distribution Division. In 1957 he was appointed Manager of the Equipment Division.

We're sure that Wade's and Paul's many friends will welcome them to their new responsibilities at Ohio Brass and welcome, too, their continuing contributions to the industry we serve.



Artist's conception of interior of giant Princeton-Penn accelerator which will occupy an area as wide as a city block and be three stories in depth. Varex Capacitor banks—96 racks with over 2000 50-KVAR units—are indicated at top of accelerator.

VAREX CAPACITORS GO INTO PRINCETON-PENN "ATOM SMASHER"

will supply power for three-billion electron-volt unit at Princeton University

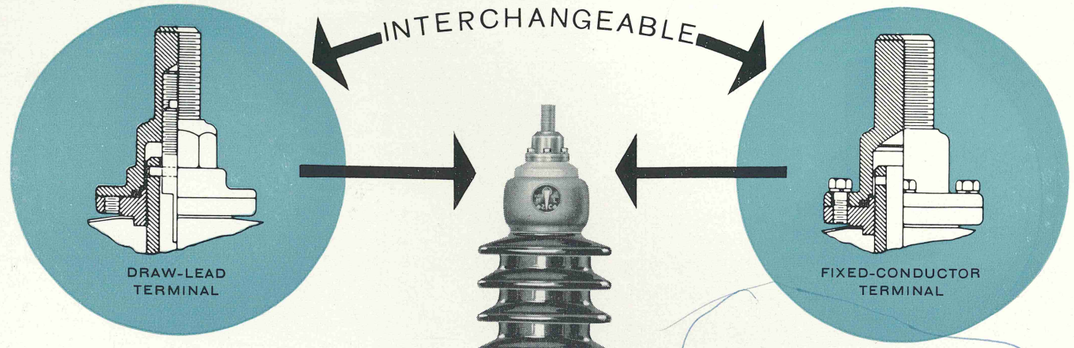
O-B Varex capacitors have been selected for a $10,000,000 particle accelerator which will be used by Princeton and Pennsylvania University scientists in basic atomic research.

The three-billion-electron-volt proton synchrotron eventually will cover 20 acres at Princeton's James Forrestal Research Center.

Similar accelerators are now being used at Brookhaven National Laboratory, Upton, Long Island, and the Radiation Laboratory of the University of California at Berkeley. However, the Princeton-Pennsylvania synchrotron will have 50 times the proton current available from existing accelerators, emitting a proton beam with the most intense concentration of "atomic bullets" ever possible.

For the first time in synchrotron construction, capacitors are being used as a major component of the main power supply system. They are alternating current power-type units. Contrary to what might be expected, the Varex capacitors are not for impulse energy storage but for providing alternating current for a huge electromagnet system, covering a circular path 80 feet in diameter and weighing 400 tons. The magnet will guide protons over a course some thousands of miles in length until they attain a top energy of three billion electron-volts.

O-B is supplying over 2000 50-KVAR type capacitor units for the accelerator which is already under construction. Target date for initial operation is mid-summer 1960. A more detailed report on the construction will be carried in Hi-Tension News soon.



ONLY ONE Breaker/Tran BUSHING FITS ALL APPARATUS AT A GIVEN VOLTAGE

great inventory economy combined with maximum service and equipment protection

At 69 kv and below, you now have the opportunity to confine your purchases to *only one* apparatus bushing per operating voltage level. This bushing, by the simple transfer of only the top terminal, will fit either transformers or circuit breakers built to ASA Standards. The economy of inventory resulting from this is only half the story. The other half — and a big half — is the assurance of having a spare bushing that will serve wherever it is needed.

In addition, this interchangeable bushing will either fit, or may be adapted to a considerable variety of older pre-standard apparatus. Therefore, the protection it affords usually goes considerably beyond modern standard station equipment. In many cases, this satisfies a much-felt need.

The bushing we describe is the new Breaker/Tran design, recently added to O-B's ASA Standard series from 23 to 69 kv, inclusive, plus an extra-standard rating for 15-kv operating voltage.

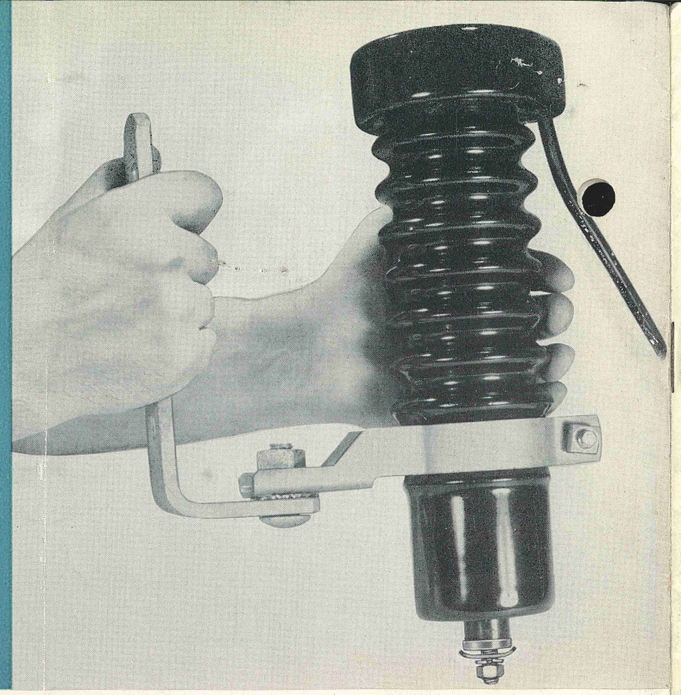
All such O-B bushings are typified by the use of tubular conductors that will accommodate transformer draw-leads, and also have ample conductivity to meet standard circuit breaker requirements. The lower terminal connection is universal for either application. By means of a simple bolted flange, the top terminal can be adapted to draw-lead use, or a second type of terminal can be applied to utilize the bushing conductor as a current-carrying member in circuit breakers or transformers. It will be seen that one complete bushing, plus an alternate terminal, covers the complete range of application.

Bushings in this category are designed to operate with an apparatus oil level 21 inches below the flange for transformers, and 16½ inches for circuit breakers. This is maximum. Oil may stand at any point above this line, thus making the bushing applicable to all transformer oil levels 21 inches or less. It is also suitable for circuit breaker oil levels 16½ inches or less. This feature is often valuable in applications to older apparatus, and also covers the full range of standard levels for 400-ampere transformer bushings.

Complete information on this bushing is available from your O-B representative. It may be obtained on all new apparatus purchases merely by expressing a preference, and at no price premium.

A notation on your requisition "O-B Breaker/Tran Bushings" will inaugurate a new order of service protection and inventory economy.

IF THEY WERE AS BIG IN SIZE AS IN PROTECTION THEY WOULDN'T GO ON TOP OF A POLE



O-B Dynagap distribution arresters put a whole new order of performance into a small package

While the O-B Dynagap is noteworthy in many respects, probably its most obvious unique property is its small size. In past lightning arrester designs, spark gap elements comparable in electrical performance were many times as large. Because of this, the demand for small size in Distribution Class arresters necessitated a special gap with limited capabilities.

In sharp contrast to this, the Dynagap structure has a diameter of only two inches and a height of approximately ⅛-inch per kv of distribution arrester rating. This miniaturized gap performs all conventional functions, as well as the highly unconventional one of supplying nearly half the power-follow current interrupting resistance -- a duty once assumed almost entirely by the valve blocks.

It is significant that when components of the Dynagap structure are manufactured, it is not known whether they will end up in a heavy duty Station Class arrester, or in a Distribution Class. The basic structures are identical.

Despite its small size, the Dynagap in an O-B distribution arrester will expand the power-follow arc from its original length of a few thousandths of an inch, to 2¾ inches per kv of arrester rating. For example, a 12-kv arrester has a total arcing length of 33 inches at the instant of current interruption.

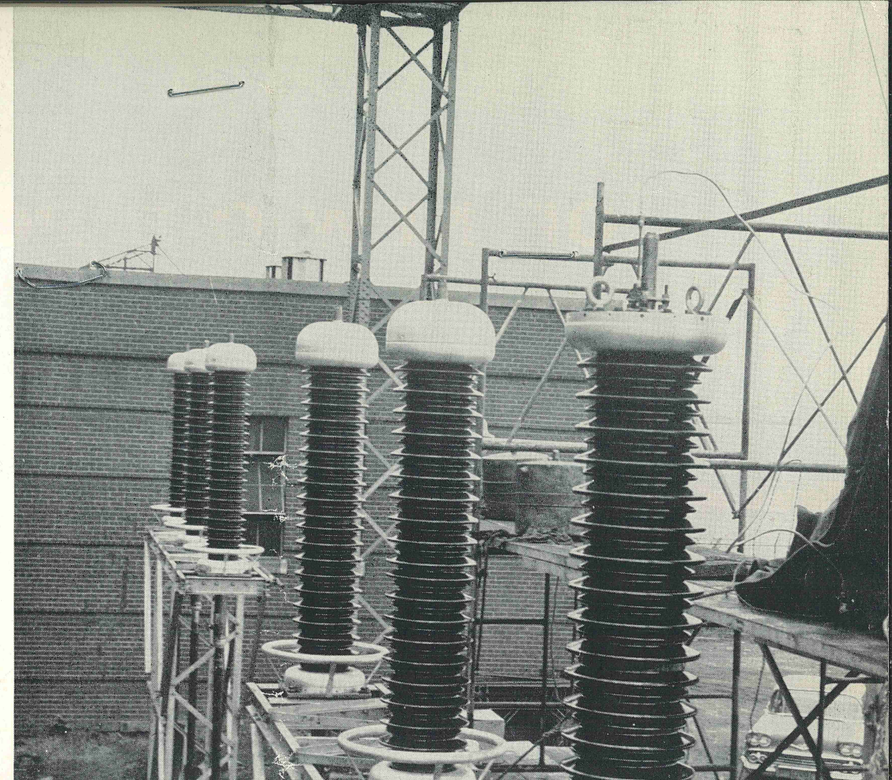
These characteristics of the Dynagap remove the modern O-B distribution arrester far out of the traditional performance range of its class. In many respects the arrester exceeds by some 300 per cent the ASA requirements for Station Class.

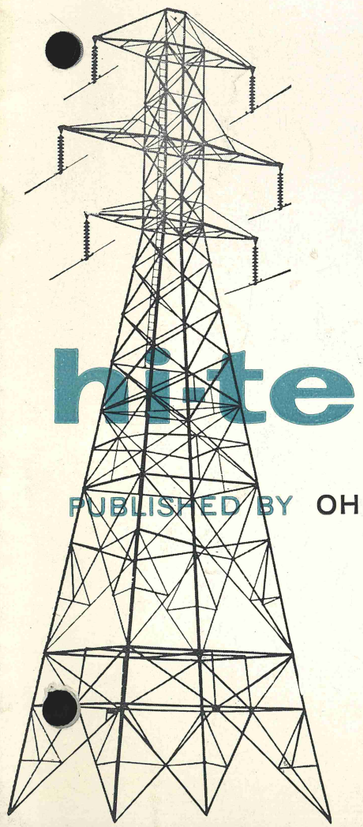
Transfer of interrupting duty from the valve blocks to the spark gap element, as previously mentioned, has opened up an entirely new field of valve block development by removing a one-time dominating requirement. Development of the new O-B block has been concentrated in the direction of increased thermal durability. While the ASA Durability Standard requires 20 applications of 75 amperes for 1,000 microseconds during a time period of 75 minutes, the O-B distribution arrester will withstand 20 applications of over 400 amperes for 2,000 microseconds in an elapsed time of only 6½ minutes. This phenomenal increase in durability goes directly to the heart of many past distribution arrester failure problems and provides a whole new order of power service continuity.

If O-B Dynagap distribution arresters, Type DV, were as big as their protection would suggest, they wouldn't go on top of a pole. In actual practice, they put all this protection into a package that is materially smaller than conventional designs.

Type DV arresters are available in all popular pole-top models, as well as a transformer-mounted unit supplied by apparatus manufacturers. They will fit every requirement of your distribution system. Take advantage of what they have to offer.

6172-H Printed in U. S. A.





hi tension news

PUBLISHED BY OHIO BRASS COMPANY, MANSFIELD, OHIO Vol. 29 No. 1

JANUARY 1960

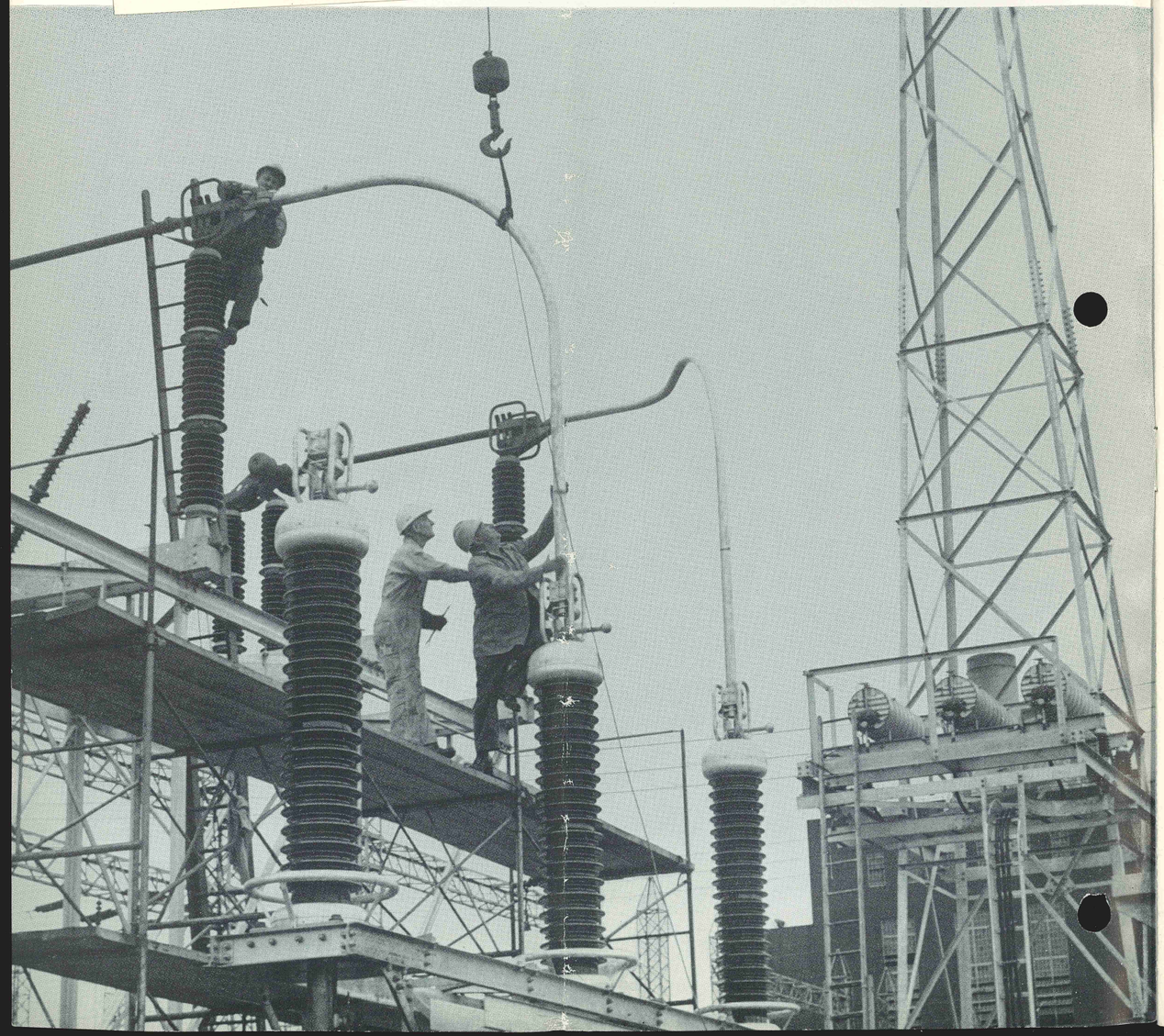
Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 12903. CLEVELAND, OHIO

THE HOLAN CORPORATION
4100 WEST 150TH
CLEVELAND 35, OHIO

DESIGN
THEAD
RECISE
CTION

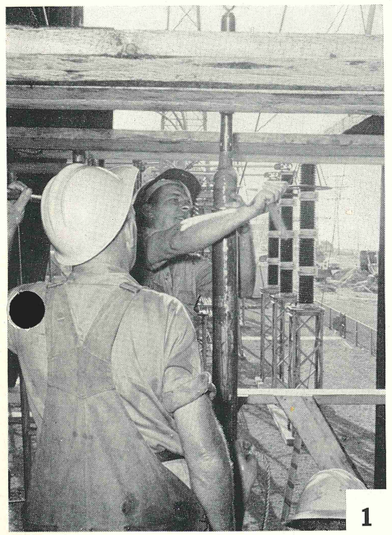


Niagara - Mohawk builds 12 terminals for 230 kv in a "Comfortable" day's work per phase

Since the O-B capacitor-graded pothead is new in both its electrical and mechanical aspects, we will follow the highlights of a field installation, which will probably answer a number of questions being put to us by interested engineers.

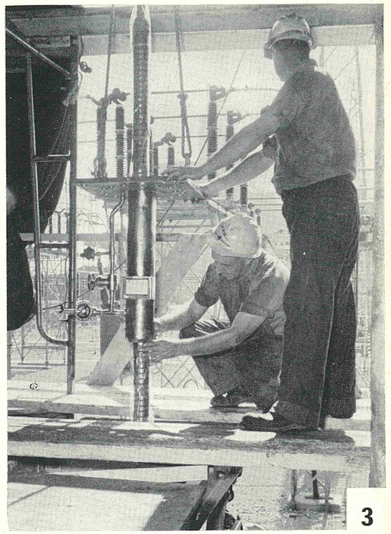
These photographs were recently obtained during the installation of 12 terminals for 230 kv at the Huntley Station of Niagara-Mohawk Power Company. This large 1200-megawatt steam plant supplies the principal output for the Buffalo district. The low-pressure oil filled cable system conducts high voltage from the 230-kv switchyard to two step-down transformers as part of an expansion of transmission facilities.

It might be well to consider a few basic features of the O-B pothead as they affect installation procedures. The series-connected, stacked capacitor units of doughnut formation are assembled over a supporting tube. This tube is wound



1

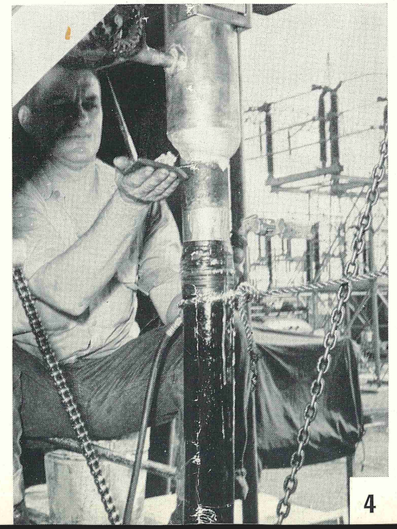
2



3

At left:
One of four sets of O-B capacitor graded potheads for 230 kv at the Huntley station of Niagara-Mohawk Power Company, Buffalo.

No. 1. Cable is cut, and the terminal is compressed onto the exposed conductor. Ends of the cable insulation are temporarily sealed with crepe paper tape to prevent excessive loss of oil, due to the positive pressure maintained constantly on the cable system.



4

No. 2. Lead has been stripped from the cable, down to a point just below the plane of the base plate. Above this, a Mylar band is applied to the cable and "tacked" in place with a hot soldering iron. Function of the Mylar is to provide a smooth, continuous surface for sealing gaskets in the base plate. This wrapping is brought to proper size for optimum gasket contact and checked with a diameter rule.

No. 3. As a protection against air and moisture pollution of the cable, a Mylar envelope is applied. Following this, the base plate assembly is lowered into place.

No. 4. A wiped solder joint, is made between the lower sleeve of the base plate and the lead cable sheath.

from low-loss, resin-coated paper under heat and high pressure to produce an adequately strong support. The capacitor assembly is factory-mounted inside the porcelain housing, and is installed without further handling on the construction site. Capacitors are vacuum-dried and oil-impregnated. The paper support tube also accepts this impregnation. For shipment, the housing is filled with cable oil and temporarily sealed. A flexible expansion reservoir, completely filled with oil is attached to the valve system to prevent the oil from coming into contact with air or other contaminants.

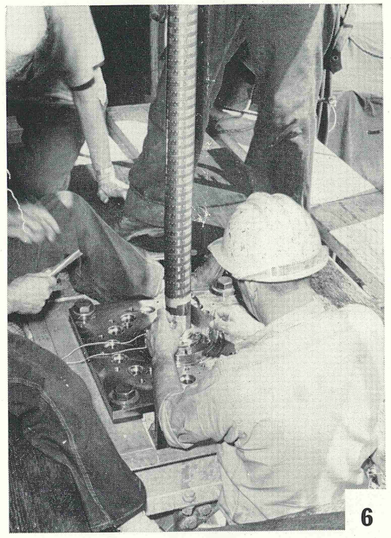
Immediately prior to installation, the expansion reservoir is removed, along with the temporary lower sealing plate. This drains the oil from inside the paper support tube -- and only from this area. Oil surrounding the capacitors is not lost. After the lapse of only a few minutes, installation of the housing is complete, and oil from the cable system re-fills the interior of the support tube.

Pictures shown here were taken consecutively during the installation of a single terminal. Certain detailed steps are necessarily omitted, but all principal operations are shown. A power company crew averaged about six hours per completed pothead. This permitted the normal starting delays and provided for some time contingency in a regular eight-hour day.

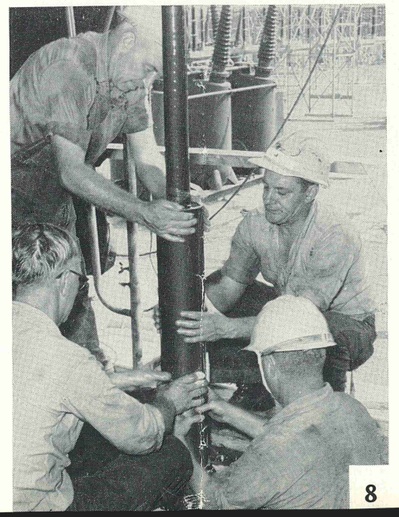
5

No. 5. Cable shielding tapes are cut slightly above the plane of the base plate, and the excess tapes stripped away for a convenient distance. The upper edge of the remaining shielding tapes is wrapped with tinned wire and soldered. End of this wire is grounded to the base plate.

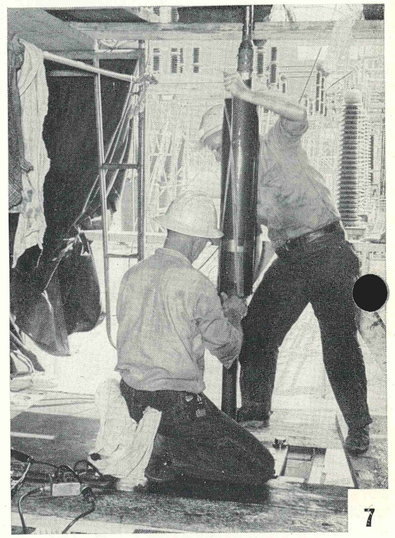
No. 6. Foil is wrapped around the paper cable insulation, and in solid contact with the exposed end of the shielding tapes below the flange. This foil provides contact at ground potential for the inner end of the helical stress cone.



6



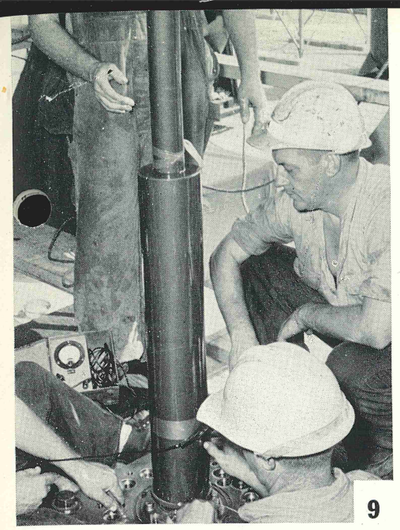
8



7

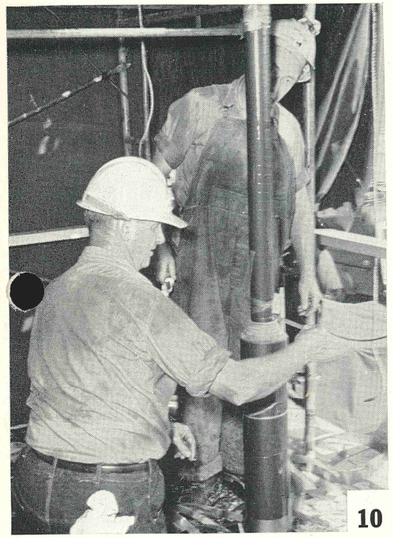
No. 7. First insulating paper build-up is lowered into place. This component is factory-wound, dried, and oil-impregnated. It is shipped in a sealed container emersed in oil and opened only when ready for installation.

No. 8. By rotating the build-up, it tightens to the cable. After it is snug, further tightening drives out any trapped air between layers and squeezes out surplus oil, to form a more dense structure. Final removal of all air is accomplished in the course of prolonged evacuation of the entire terminal before it is energized.



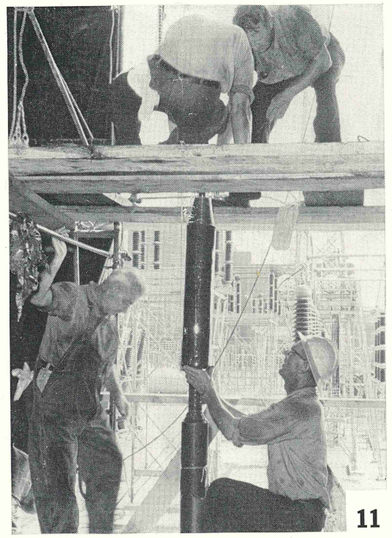
9

No. 9. The O-B pothead uses an exclusive method of forming the stress cone. A ribbon of foil is applied to the surface of the build-up paper, at a slight and decreasing angle. As the build-up is wrapped, this foil ribbon winds into a perfectly formed flared shape of carefully calculated curvature. This is in sharp contrast to former, somewhat primitive methods of field installation. End of the foil ribbon may be seen beneath the first layer of build-up paper. This stress cone is grounded at both ends. To confirm correct grounding, solid connections, and continuity of the ribbon after wrapping, an electrical test is made before work progresses.



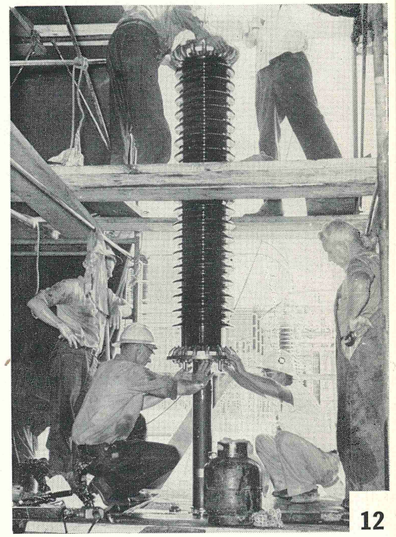
10

No. 10. An ingenious method is used for "penciling" the end of the build-up. Starting at a measured distance below the top, the end of the paper was torn away by an unwinding action. Each torn edge, in turn, guided the succeeding tear which was a few thousandths of an inch longer, due to thickness of the paper. By a simple process of unwrapping, a smooth cone was automatically formed; better and much quicker than by the older method of carving.



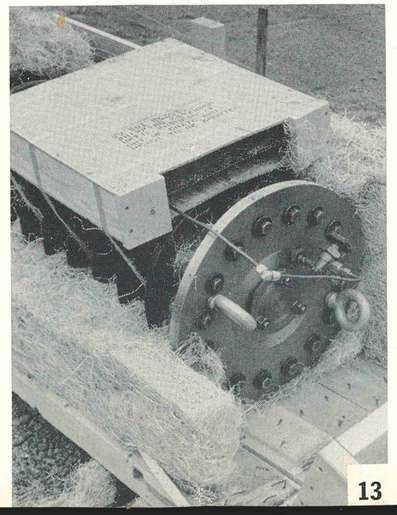
11

No. 11. The second or upper build-up is lowered into place. This piece is tapered at the factory for proper pencil shape on the ends. All the taper is now shown at the top, but in the course of tightening, this is equalized at both ends. Following completion of both build-ups, crepe paper tape is wrapped to fill the central vacancy and to extend the insulation between the top of the build-up and the terminal. This wrapping is brought to the outer diameter of the work. Final diameter is checked by slipping a piece of capacitor support tubing, supplied for this purpose, down over the build-up, and removing sufficient paper to permit slight clearance.



12

No. 12. Porcelain housing and integrally mounted capacitors are lowered over the build-up. This is followed by torque-tightening the series of flange bolts, and by final adjustment and securing of the top terminal. At this point, installation is complete. This particular pothead was completed in about 5½ hours.



13

No. 13. Method of packing the O-B pothead for shipment. The interior is completely filled with cable oil and, to compensate for expansion and contraction, a temporary bellows-type oil reservoir is filled and attached to the evacuating valve. This remains in place until the central chamber of the pothead is drained just before installation.

two-minute tours no 2

HOW FUTURA INSULATORS ARE MADE

the "shape of the future" is formed on the industry's most modern production line

Last month, in our first "Two-Minute Tour," we described how a precisely formulated mixture of ball and China clays and other ingredients enters Futura's mile-and-a-quarter-long synchronized conveyor system -- and how it is prepared for the forming operations.

Immediately before the clay enters the forming operation, it is shredded and re-blended -- for the second time -- to insure a smooth homogeneous consistency throughout every cubic centimeter of its mass. The operation takes place in a special pug mill which is held under a high vacuum in order to remove all air from the clay mixture as it is shredded and reblended.

This, of course, contributes to an extremely dense, fine-grained porcelain, free of voids which might eventually shorten the life of an insulator.

The clay is then extruded from the lower end of the vacuum pug mill in the form of a short cylindrical column. An automatic cutoff, actuated by an electronic measuring device, cuts the column into "blanks" -- each blank containing enough clay to make one insulator. As the blanks are cut, they are automatically positioned on forming platens.

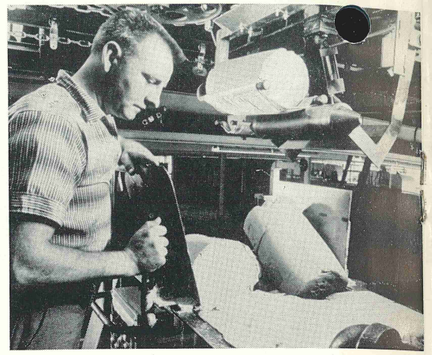
The automatic forming of the clay blanks takes only a few seconds. The exterior or top surface is hot-pressed first, then the piece is inverted and placed in a plaster mold, exposing the unformed underside. The underside -- the petticoats and pinhole -- are then hot-pressed (another position on the same automatic machine), the flash is trimmed off, and the piece continues on the synchronized conveyor system to the mold release dryer.

In the mold release dryer, the freshly formed clay dries and shrinks enough to free the pieces from the molds (allowance has been made, of course, for the exact percentage of shrinkage).

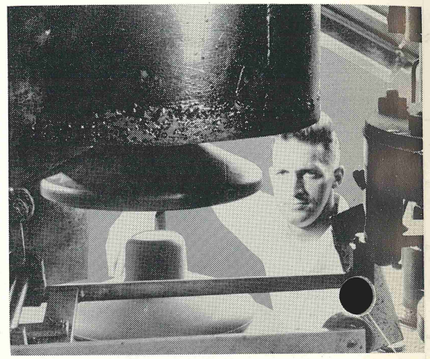
The pieces are then automatically removed from the molds and transferred to the conveyor line entering the final drying cycle. Although the handling and transfer movements are completely automatic, the vacuum lifting devices employed are far more delicate and precise in their work than any human hands.

The final drying cycle removes all moisture from the ware, preparing it for the important operations which precede kiln firing.

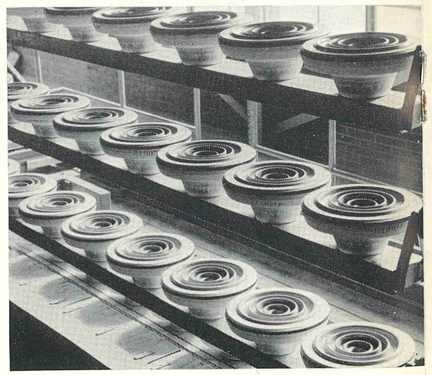
We'll follow those operations in our next "Two-Minute Tour."



Clay banks arrive on overhead conveyor from clay department and are automatically fed into this vacuum pug mill. Mill removes all air from the clay prior to shaping.



The pug mill extrudes the required amount of clay onto the forming platen, and the exterior (top) shape of the insulator is hot pressed.



Conveyor filled with newly-formed insulators on their way to the mold release dryer typifies highly mechanized system now used to produce O-B insulators. Units harden sufficiently in the dryer to permit automatic release from the molds.

After passage through the mold release dryer, insulator shapes are gently removed from the molds by vacuum lift devices and then conveyed through the final drying cycle. Vacuum lifts are completely automatic, far more delicate and precise than any human hands.

DISTRICT MANAGER PAUL LAMONT MOVES TO NEW YORK CITY OFFICE

District Manager Paul C. Lamont has moved his headquarters from Syracuse to O-B's New York City office. Here he will continue to serve customers throughout the state and will take on additional responsibilities including many of the accounts formerly handled by David H. "Dinty" Moore who retired September 1.

A graduate in Engineering and Business from the University of Pittsburgh, Paul joined O-B in 1949 as a District Manager in the Mining Division covering the anthracite coal region of Pennsylvania. In 1953 he was given added responsibilities for power utility and railway sales in a territory including parts of New Jersey, New York and Pennsylvania. In 1956 he transferred to Syracuse, New York from which he covered all of the state except for the New York City area.

Paul's broad knowledge of O-B products and his familiarity with many of the area's utility industries has well prepared him to serve his new customers.

MAKE THE FIRST COST THE ONLY COST

if you're going to need extra insulation . . . ever . . . now is the time to put it in

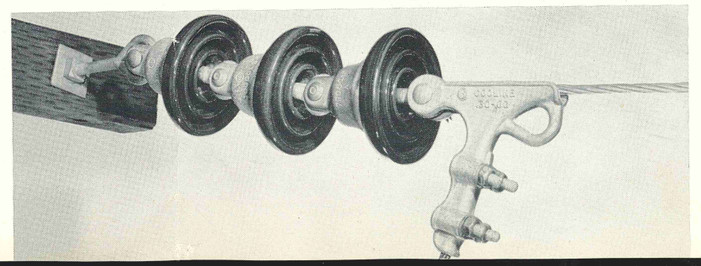
It's as simple as this . . . as you rebuild deadends and build new primary distribution lines, install enough insulation to meet tomorrow's requirements. At strain positions it will save a lot of future labor expense, and give you assurance that the line is insulated to handle future voltage.

In other words, while the lineman is at the pole top the cost of adding an extra insulator is no more than the cost of the insulator. But changing a deadend from one to two, or from two to three insulators, in ten years will be a major expense.

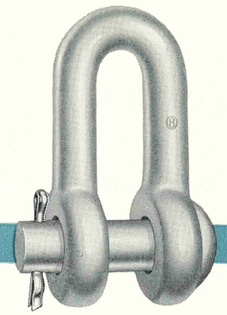
Nearly everyone is restudying future distribution voltage requirements, and deciding now which distribution deadends will provide adequate insulation for tomorrow's voltage. They know systems are going higher and higher to meet the ever-increasing per-customer use of electricity. Many farsighted distribution engineers are already talking about primary residential distribution at a voltage two to four times as high as their present system voltage.

You alone know how high you should go. All we want to do is urge you to make adequate allowance for future loads and to point out that installing extra insulation at deadends now will make raising voltage that much easier later on.

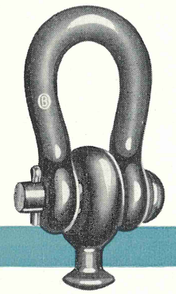
That extra insulator will never cost so little again. When you put it in, we suggest you use the best—an O-B insulator.



CHAIN SHACKLE No. 79610
A basic means of clevis type suspension insulator attachment. Strength rating on this design goes as high as 75,000 pounds.

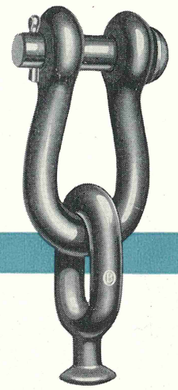


BALL HOOK No. 78420
This hook is self locking. It is first attached to the support, then connected to the insulator. The cap closes the opening and prevents release by accidental uplift.

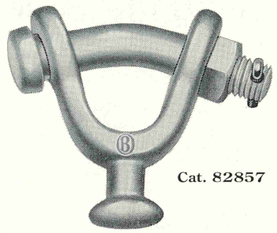


Cat. 70711

TOWER FITTINGS
No. 70839, used chiefly for deadends, and No. 82857, can be installed directly on the structure. No. 70711 requires some intermediate fitting such as a U-bolt.

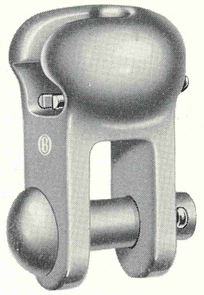


Cat. 70839

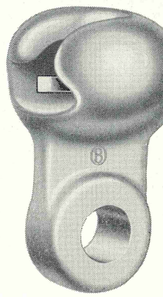


Cat. 82857

SOCKET CLEVIS No. 87603
Intermediate fittings used to make connections between ball fittings and those with drilled tongues or eyes.



SOCKET EYE No. 11544
For attaching conductor hardware to the lower end of a ball and socket suspension string. There are 21 styles to fit various clamp sizes.



YOU FIND O-B QUALITY HERE, TOO

miscellaneous hardware made to withstand the tests of time and corrosion

The same care O-B takes in manufacturing suspension insulators and conductor clamps also goes into its line of miscellaneous transmission hardware.

You'll find just as much strength and resistance to corrosion in an O-B hook or shackle as there is in other O-B products. It stands to reason that the hardware joining an insulator string to a tower has to be of the same high quality.

Only the best manufacturing methods are followed in making miscellaneous hardware, whether the item is forged, cast, or formed.

The malleable iron used for cast parts in miscellaneous hardware provides it with inherent resistance to corrosion. But for even more effective protection, malleable iron items are hot-dip galvanized, as are steel hardware products.

To meet the special requirements of high-contamination, high-corrosion areas, miscellaneous hardware can also be forged or cast in bronze.

Humpback cotter-pins are used on rivets through ¾", to facilitate hot-line work and cut down on labor costs.

There is a wide selection of O-B miscellaneous hardware items from which to choose, and they are available for quick delivery, usually direct from stock. Extra-fast service can be obtained on some of these items by ordering standard-package quantities (ask your O-B representative about these).

Keep in mind that these smaller pieces are full-fledged members of the O-B insulator-hardware team that's "designed together to work together." They have been in service on transmission lines for many decades and have withstood the severest tests of time and corrosion.

When you need miscellaneous hardware, you can make no better choice than from Ohio Brass.

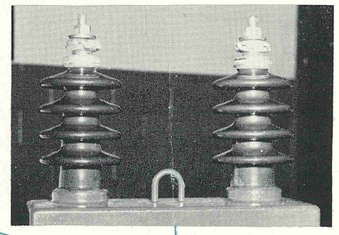
"WHAT'S IN IT FOR YOU?"

Unique features of O-B Varex capacitors mean convenience in installation, long life in service

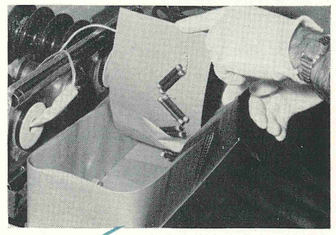
TERMINAL ASSEMBLY: High-strength stainless steel studs have special threads without pointed crests. If nut is overtightened, nut strips -- preventing damage to stud. Nut is cadmium plated brass, can be replaced, if damaged, by any standard ½-13 NC nut.

Stainless steel Belleville washers keep conductors clamped under constant pressure. Identical clamp halves are cadmium-plated bronze, accommodate wire sizes from 2/0 stranded to 10 solid.

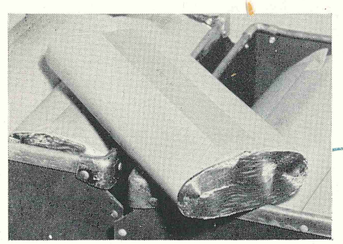
CONTAINER TOP: Varex container top has these distinctive features: (1) a centrally located lifting eye which makes the unit easier to handle, hoist, and install in pole top racks; (2) O-B wet process porcelain bushings with long leakage distance; and (3) bushings that are hermetically soldersealed to the top of the container without intermediate metal bands. The process used here assures leak-free performance throughout the life of the capacitor.

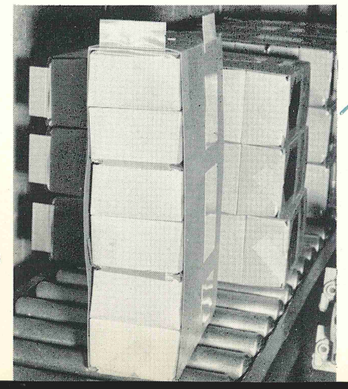


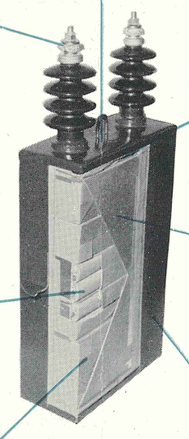
DISCHARGE RESISTORS: Molded carbon discharge resistors, a necessary safety feature, discharge the capacitors in considerably less time than is required by NEMA Standards. Heavy lead wire gives an excellent current path from bushing terminals to element contact plates. Paper tubes made of multiple layers of capacitor tissue provide superior insulation for lead wires.



ELEMENTS: Varex elements have no inserted tabs, thus eliminate points of concentrated stress and maintain an active dielectric which is uniform throughout. The element has extended foils which means that electrical contact can be made to every turn of the foil and outside of the active dielectric. Coded numbers stamped on each element make possible an exacting degree of control in manufacture, furnish an accurate record of the source of every component part.

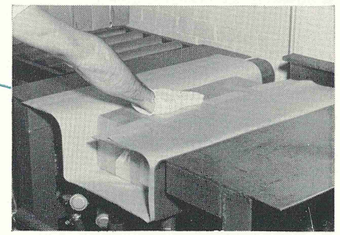






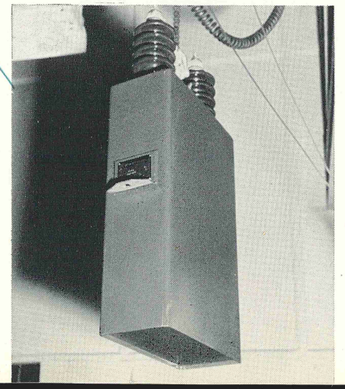
SECONDARY INSULATION: Secondary insulation is made of multiple sheet kraft capacitor tissue of superior dielectric strength. This insulation is wrapped completely around all internal parts.

Springs outside this insulation maintain pressure on the contact plates to insure a good electrical connection to the elements.

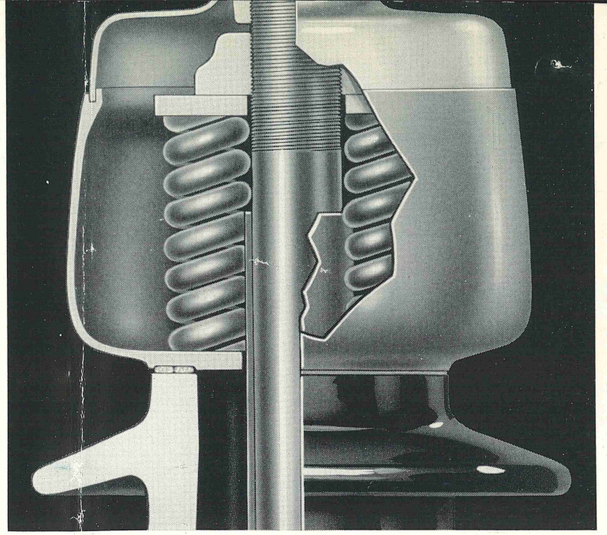


PACK ASSEMBLY: The pack assembly shows the contact plates used to join elements in series and parallel combinations. It also shows the insulating barriers that separate elements operating at different potentials. Notice the pack retainer, which keeps the elements at uniform height for consistent capacitance in any voltage rating.

CONTAINER: The container shown here is our low-carbon Type-304 16-gage stainless steel. The container is also available in zinc-sprayed 16-gage mild steel. The recessed bottom reduces the possibility of scratching during handling. Mounting brackets are made of the same materials as containers and are securely welded to the container body. The epoxy paint finish is unequalled on any other capacitor. The clear nameplate is made of stainless steel.



WELL-PROVED ASSEMBLY PRACTICE USED IN NEW LOW VOLTAGE BREAKER/TRAN BUSHINGS



Coil springs, factory-adjusted for optimum assembly compression, maintain their original force -- and the original rigidity and tightness of the bushing -- for life. This exists regardless of expansion or contraction, or change in gasket volume. Only coil springs, with their long amplitude of movement, can assure such follow-up pressure under all conditions of exposure and operation.

Dynamic coil spring compression assures positive follow-up force over large amplitude

EDITOR'S NOTE:
If the name Breaker/Tran is not yet familiar, it is because it denotes a completely new series of O-B bushings for voltages from 15 to 69 kv. This line of bushings is distinguished by universal interchangeability between circuit breakers and transformers. Internal construction of these new bushings follows conventional high voltage practice, namely, a condenser insulating core fully oil-impregnated and oil-immersed from end to end, enclosed in an oil-tight housing. This is the construction popularly known as oil-paper.

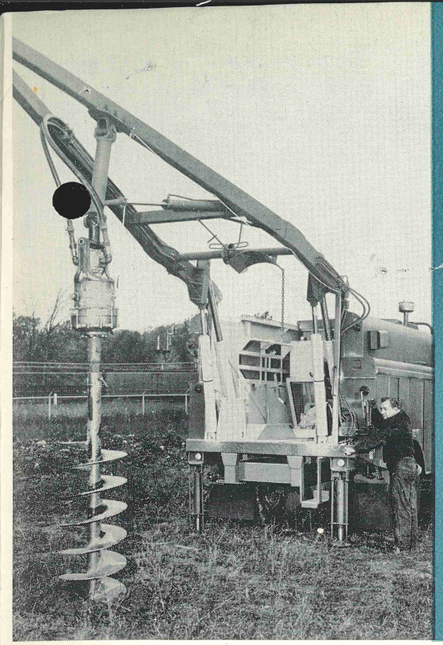
Breaker/Tran bushings are not mere second cousins of the O-B high voltage types -- they are brothers! Construction practices in each class are identical. This fact is best brought out by the spring compression assembly used in the new low voltage category.

While this method of bushing assembly is broadly used, it is subject to many variations. One of the more economical versions uses a spring with an amplitude of movement of only a few thousandths of an inch before mechanical force drops off abruptly.

One must consider the end-to-end relationship of bushing parts. There are two porcelain housings. There is an aluminum flange and ground sleeve. There is an oil expansion reservoir. There are four gasket joints. All parts expand and contract with temperature change. Gaskets, after years of loading, characteristically lose part of their original volume. The precise total length of a bushing, therefore, is not an everlastingly unchangeable condition.

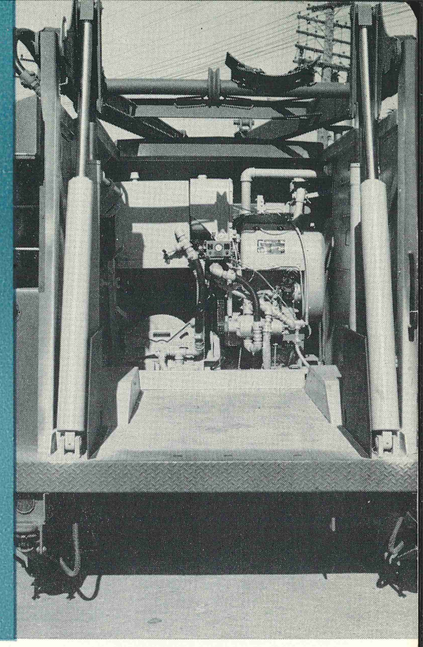
One thing that must not change, however, is assembly compression. This controls rigidity of the bushing and the efficiency of gasket seals. In the O-B design, this force is applied by a series of compressed coil springs. Their amplitude of movement without appreciable change in mechanical force is many times the slight dimensional differences that will ever occur. Therefore, a great safety factor in assembly compression is present, and parts are always under dynamic follow-up pressure.

This is the assembly practice used in the highest voltage O-B bushings. It is the best we know of. Adoption of it, unchanged, into smaller, less expensive bushings is typical of the quality you will find throughout the Breaker/Tran line.



At Left
Holan's new Uni-Power Body is shown equipped for pole-setting assignments. The 6826 Derrick, 5400 Earth Borer and 5095 Jacks are all hydraulically-operated. A 56 hp gasoline engine, mounted in the front of the bed, supplies power for the hydraulic system.

At Right
This close-up view shows the compact arrangement of the "power package" of the new Holan Uni-Power Body. The 56 hp Wisconsin engine, hydraulic pump and oil reservoir and Braden Model CL Hydraulic Winch are mounted as a unit. The complete unit -- or component parts -- can be removed for repair or replacement without removing the body or hydraulic piping.



INDEPENDENT POWER UNIT DRIVES HYDRAULIC EQUIPMENT ON NEW HOLAN UNI-POWER BODY

A unit designed to power all hydraulic equipment needed in utility construction and maintenance work has been made an integral part of a new body manufactured by Holan Corporation.

The body, power plant and hydraulic equipment are built as a unit for placement on the chassis. The new body is called Uni-Power Body.

Power for operating all hydraulic equipment is provided by the 56 hp Wisconsin 4-cylinder air-cooled engine mounted in the body just behind the crew compartment. A Braden Model CL Hydraulic Winch and a tandem hydraulic pump with 50-gallon oil reservoir complete the power package.

Because the Uni-Power Body is built as a unit, all hydraulic piping is under the floor of the body and clear of the chassis. The body can be mounted -- or removed -- without disturbing hydraulic lines.

Standard body manufacturing procedure is to mount the winch, power take-off, and hydraulic pump on the chassis. Preliminary hydraulic piping is then done on the chassis before the body is bolted into place.

This new concept of construction makes it possible to mount all auxiliary equipment -- such as winch, power plant, hydraulic pump and lines, derrick -- on the body. The body is then bolted to the chassis and is ready for the road.

This new method of body construction offers many user advantages. When the chassis is at the Holan plant, a Uni-Power Body can be mounted in a matter of hours - not weeks. Or the new bodies can be delivered in trailer loads to the user's garage, completely painted and ready for rapid mounting to chassis. A Uni-Power Body can be carried as a "spare" and placed on a chassis in two or three hours, thus eliminating tie-ups of expensive crews.

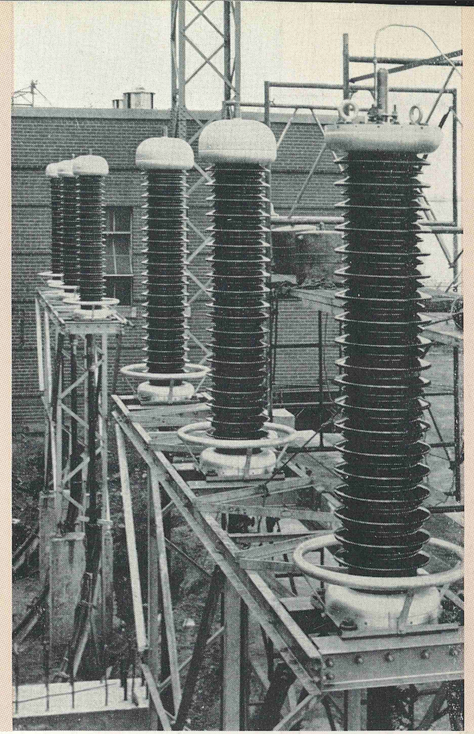
The power plant can be lifted from the body as a unit for repair or replacement. Or any of the component parts can be easily removed. The body does not have to be removed in either case -- thus cutting "down time" for maintenance work.

Gasoline used in this stationary power plant is free of road tax. Engine idling -- necessary with standard power take-off -- is eliminated. This reduces engine wear and cuts maintenance costs.

The Uni-Power Body shown here is a CMC-164 with crew compartment. The hydraulic equipment includes the Model 6826 Hydraulic Derrick, the Series 5400 Heavy Duty Multiple-Speed Earth Borer, and Series 5095 Hydraulic Jacks.

For more information about the Holan Uni-Power Body, please return the enclosed reply card. Holan Corporation is a wholly owned subsidiary of The Ohio Brass Company.

QUICK CONSTRUCTION OF NEW O-B POTHEAD REDUCES EXPOSURE OF CABLE INSULATION



Each of these potheads was completed in a normal working day, with cable exposure reduced to five or six hours. Design of these new devices is highly refined and many older time-consuming details are eliminated by means of factory-assembled components. This has the further advantage of reducing critical operations in field installation.

many one-time laborious field operations now included in factory-assembled components

On a recent installation of 12 O-B capacitor-graded potheads for 230 kv, it was demonstrated that a terminal even of this size could be installed easily in an eight-hour day.

While the reduced labor cost was naturally welcome, this factor was secondary. The important consideration was minimum exposure of the paper-insulated, oil-filled cable. Five or six hours per terminal were about the average. This is an extremely valuable feature of the new O-B pothead, as those who work with cable systems will readily appreciate.

Design of this pothead emphasizes factory assembly of as many components as possible, and the elimination or reduction of critical operations performed in the field. For example, while stacked capacitors surround the cable for almost the entire height of the pothead, these are an integral part of the porcelain housing. They arrive on the job, and are installed, contained within the housing and sealed in their own oil, and are never exposed or handled. This factor, alone, could account for a saving of several hours.

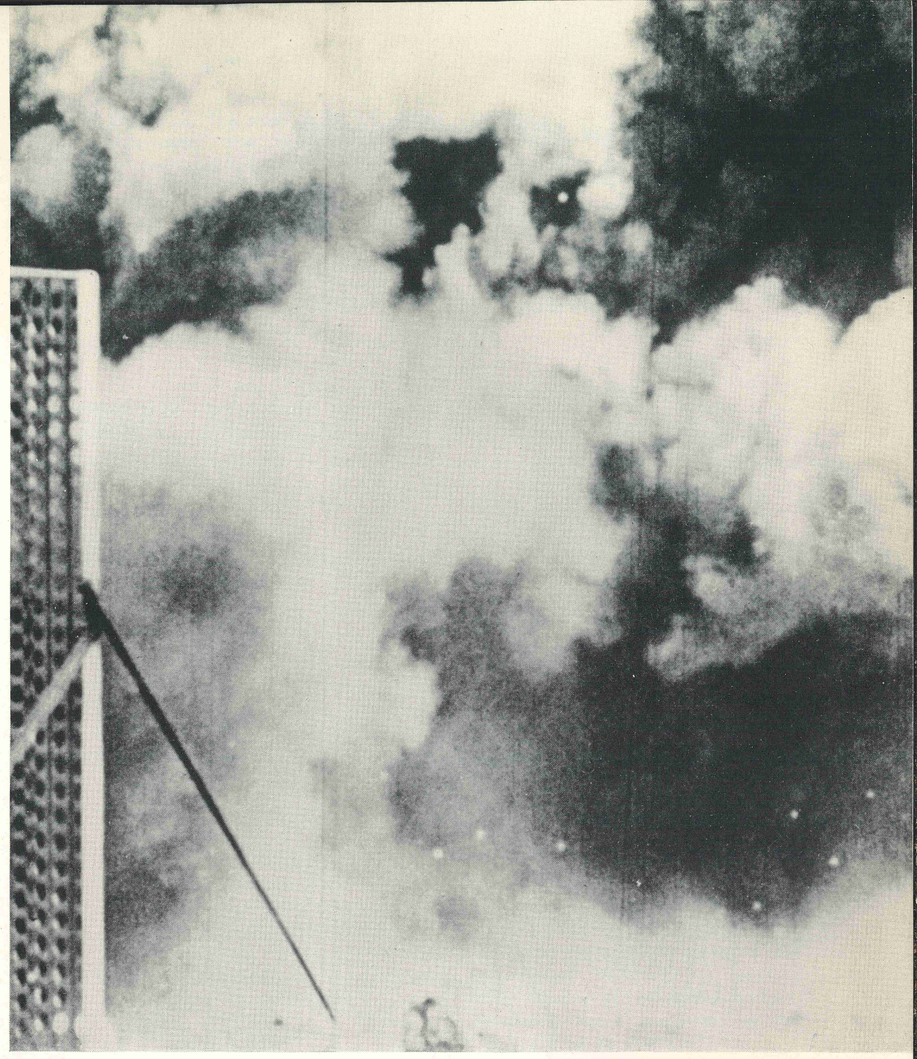
Another instance: The O-B stress cone is formed at the factory by attachment of a continuous ribbon of foil to the lower paper buildup. When this is wound, the foil forms a perfectly shaped helical cone resulting from the angle of the ribbon on the paper. In about ten minutes, the lower buildup with its stress cone is completely installed. It should be noted that, since the shape of the cone is predetermined and cannot be altered, maximum efficiency of this element is now controllable. Anyone who has observed the production of a stress cone as a field operation can readily evaluate the advantages in the O-B design, both from a standpoint of time-saving and precision.

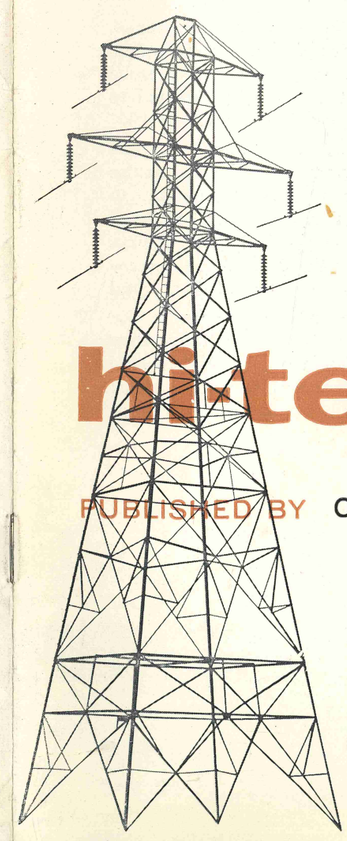
Capacitor-graded potheads, as completely self-contained units, are one of the newer O-B developments. They relieve the problems of electrical grading of terminals in the same general way and degree as a condenser type bushing. O-B designs are presently available for 115 kv and all higher voltages, including EHV applications. They are adaptable to any type of oil-filled or gas-filled cable system.

Your O-B representative will be glad to discuss this equipment with you, and obtain any specific information you may seek. Be sure to investigate this new development in connection with any future plans for cable installations.

6173-H Printed in U. S. A.

Massive fault-current tests have been conducted to prove effectiveness of Thorex arrester pressure-relief. Here is one test at its maximum stage. See page 10 for a complete report.





hi tension news

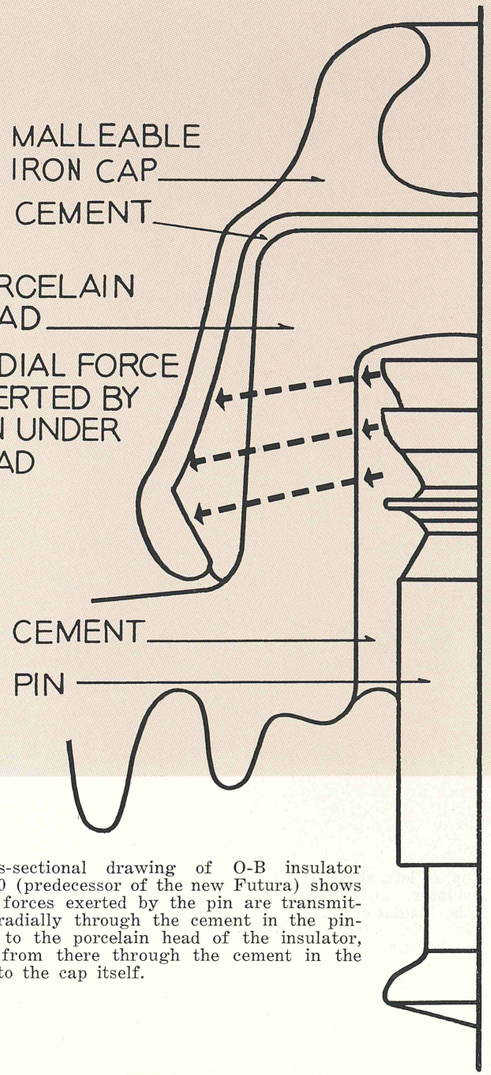
PUBLISHED BY OHIO BRASS COMPANY, MANSFIELD, OHIO Vol. 29 No. 2

HOLAN

FEBRUARY 1960

how the development of improved research tools aided the development of an improved insulator design

FUTURA



Cross-sectional drawing of O-B insulator 32440 (predecessor of the new Futura) shows how forces exerted by the pin are transmitted radially through the cement in the pinhole to the porcelain head of the insulator, and from there through the cement in the cap to the cap itself.

EDITOR'S NOTE: Since the introduction of the Futura insulator last July, our efforts in this publication have been directed primarily toward a more complete explanation of the substantial benefits users should expect from this insulator as a result of the incorporation of the Corrosion Intercepting Sleeve -- Futura's exclusive built-in protection from present and future corrosive attack.

While the Corrosion Intercepting Sleeve is, in our opinion, one of the most distinctive and unusual features of this new suspension insulator design, it is not -- by any means -- the only point of clear superiority over older and more conventional designs.

We believe the information which will appear in subsequent issues of this publication will offer convincing proof of this superiority in terms of important additional benefits to the insulator buyer and user.

Before we start taking the insulator apart, however (in order to show how it was put together), we thought that some of our readers might be interested in a glimpse, at least, of the kind of technical preparation that preceded the creation of the industry's newest suspension insulator design.

A NEW DESIGN BASED ON NEW RESEARCH!

Among the early problems confronting O-B engineers in their search for an improved insulator design was the problem of determining -- more precisely and more accurately than ever before -- what actually happens to an insulator when it is subjected to various types of mechanical and electrical loads and stresses.

Conventional tools and tests, techniques and instrumentation, were frequently too crude to probe many of the areas they wanted to explore more thoroughly.

They had to develop, for example, a new technique of impulse testing, new instrumentation to record fast waves (of the order of .01 micro-seconds), improved ways to measure the deflection of porcelain under mechanical load, and other new laboratory aids.

Some of the new tools they developed will be revealed for the first time in future technical papers; others will be discussed in this publication.

Illustrative of these new research techniques is the method arrived at (some six years ago) for obtaining precision measurements of the diametrical deflection of porcelain during loading.

When a load is applied to a suspension insulator, as shown in the accompanying sketch, the wedging action of the pin exerts a force which is transmitted radially through the cement in the pinhole to the porcelain head of the insulator, and from there through the cement in the cap to the cap itself.

If it were possible to measure accurately the infinitesimal radial deflection of the porcelain under these forces, it would be possible to calculate more accurately their direction and magnitude -- and to make such changes in the shape of the pin, the porcelain, and the cap as would redistribute these forces, and the applied counterforces, to make a stronger insulator.

The measuring equipment used was a commercial transducer and a gauging instrument mounted on a suitable platform on the test insulator.

The device used for gauging the deflection of the porcelain under load, and the actual test setup, are shown in the accompanying pictures.

The two sharp probes of the gauge are positioned directly against the porcelain head of an assembled insulator through holes drilled in the malleable iron cap. Deflections in the porcelain resulting from mechanical loading are transferred by the probes back to the transducer, which supplies an electrical signal proportional to movement.

By this means, it was possible to plot deflection curves to show micro-inches of contraction and/or expansion of the upper and lower portions of the porcelain head as the load was applied.

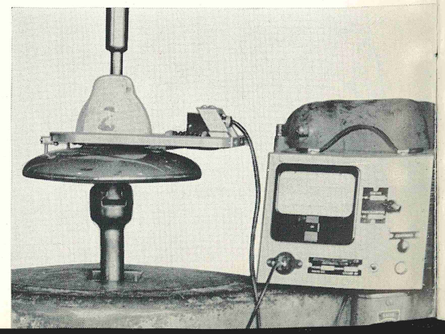
Examination of these curves made it possible to analyze the action within the head of the insulator, to discover the high stress points, and to suggest deflection controls to relieve these stress points and prevent failure until higher mechanical loads were reached.

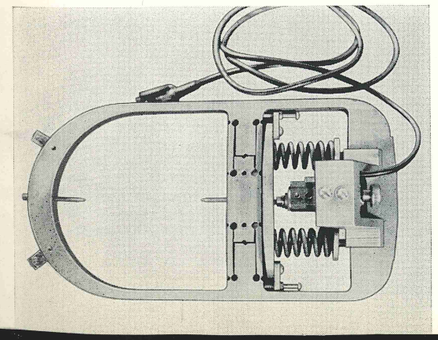
These experiments, along with many other mechanical and electrical tests, were of course instrumental in helping O-B engineers achieve design improvements that resulted in greater strength for Futura insulators.

And this greater strength, we'd like to point out, has resulted primarily from *a more effective use of existing materials -- without any penalty of increased weight, increased cost of materials, or increased cost to the user.*

That's one of the many reasons why the O-B Futura insulator is unquestionably today's best insulator value!

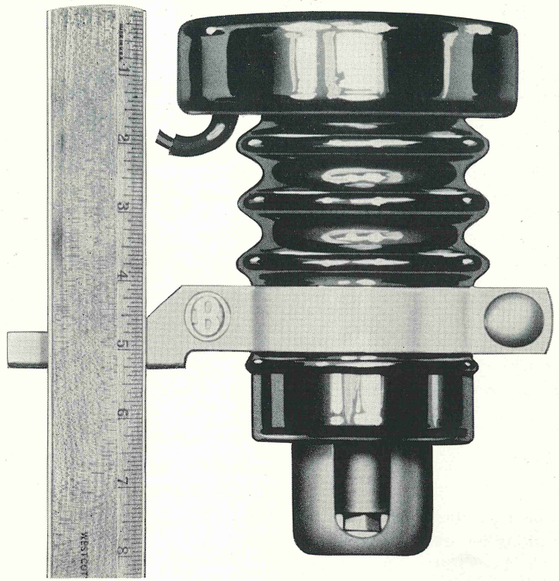
We'll offer more reasons why in our next issue.





Gauging instrument, showing the two sharp probes which are positioned directly against the porcelain head of an assembled insulator through holes drilled in the malleable iron cap.

Test set-up, at left, shows the gauge mounted on a test insulator. Deflections in the porcelain head of the insulator are transferred to the transducer, which supplies an electrical signal proportional to movement.



This 3-kv Thorex Dynagap distribution arrester is no more than a small handful, but its remarkable protective element provides 8¼ inches of 60-cycle arcing length, and durability nearly three times that required under ASA Standards for heavy duty Station Class arresters.

UNIQUE ACTION OF DYNAGAP PRODUCES FINEST DISTRIBUTION ARRESTER

Unheard of durability made possible by entirely new relation between gap and valve element

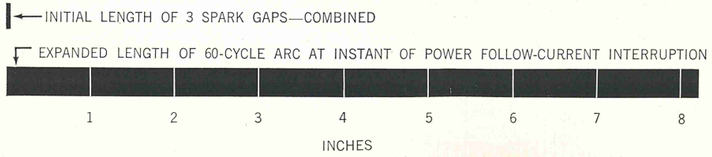
Common to all valve-type lightning arresters, those in distribution service must interrupt the flow of 60-cycle power follow-current after diverting the over-voltage transient. This is accomplished by the combined resistance of the valve element and the spark gap, limiting the current to a value the gap can interrupt. In traditional designs -- other than the Thorex Dynagap -- the valve element supplies in the order of 98 per cent of the necessary resistance, and the remaining minute quantity comes from the spark gap.

The Dynagap has rearranged these percentages drastically. In the Thorex Distribution Class, nearly 50 per cent of power follow-current limiting resistance now resides in the gap. From the initial sparking distance of a few thousandths of an inch, the 60-cycle arc is expanded in length 100 times by magnetic force. This arc-expansion, accompanied by a cooling action, builds instantaneous arc voltage to a point beyond the capacity of the system to supply it, at which time extinguishment occurs. Thus the resistance of the valve element is vastly reinforced. A 3-kv Thorex distribution type arrester has 8¼ inches of arc expansion length. Such a condition as this is absolutely unique to the Thorex arrester. Dimensional relationship of initial sparking distance and total arc length are shown here graphically.

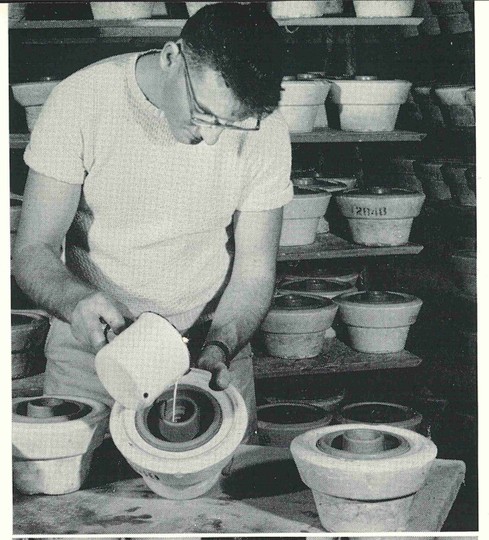
Because of the very short initial sparking distance, sparkover values of Thorex Dynagap distribution arresters can be held exceptionally low, thus contributing materially to maximum protection. However, because the valve element has been relieved of a once-dominating function in power follow-current interruption, this has opened an entirely new field of development in the direction of long-duration durability. Under ASA Standard test, the durability of a Thorex distribution arrester is approximately three times that required by the industry for the heaviest-duty Station Class.

In only one category is the Thorex Dynagap Type DV like any other distribution arrester -- price. In every other respect it more closely resembles, or even exceeds, the performance requirements of much larger and more costly types. Are you taking advantage of this clear superiority on your own system?

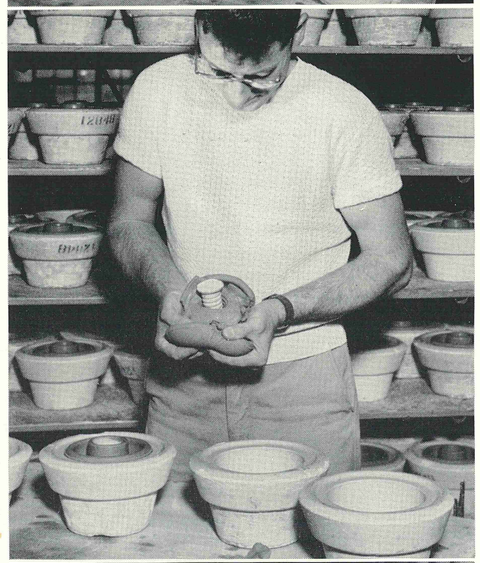
3-KV THOREX DISTRIBUTION CLASS ARRESTER



Graphic presentation of the ratio between sparkover distance and maximum 60-cycle arcing length in a 3-kv Thorex Dynagap distribution arrester. Because the initial gap is so extremely short, sparkover can be kept low. Because of the phenomenal arc expansion, an entirely new order of thermal durability can be incorporated.



Special non-shrinking plaster is poured into the pin hole and permitted to harden.



When hard, the plaster is removed from the insulator.

All gauging operations then can be performed on the plaster casting to assure pin-hole uniformity.

PINHOLES AND PINS MADE TO GO TOGETHER

When a lineman screws an O-B Pintype insulator onto a pin without any trouble, we're sure he doesn't stop to wonder how come the fit was perfect. Since the insulator was made by O-B, he most likely took for granted that it would go on the way it should.

A long time before the insulator was delivered to the job site, we knew it would fit, too. We had planned it that way, and not only for that one insulator but for all O-B Pintypes. You may be interested in knowing how we do this.

To insure pin fit, frequent sampling of pin holes must be made as soon as the units are formed from the soft clay.

In its freshly molded state, a Pintype is softer than putty. Any customary gauging operation on the threaded pinhole would deform it and thus give no accurate answer. We measure these threads, however, down to the thousandths of an inch. It is done by pouring into the pinhole a thin mixture of special non-shrinking plaster. When hard, this cast is removed from the plastic clay and all gauging operations performed on it. This operation is performed regularly to check the threading tools, the machines, and the care used in making Pintypes.

While this method may seem obvious and simple, we point out that if it were that obvious and simple O-B Pintypes could not have gained their long-standing reputation for being the Pintypes you can trust to fit the pin.

HOW FUTURA INSULATORS ARE MADE

giant finishing wheel performs half-dozen operations on 60 insulators at a time

In our preceding "Two-Minute Tours," we followed the mile-and-a-quarter-long Futura conveyor line to the point where the newly formed insulator shapes enter the final drying ovens.

As the ware leaves the ovens, it is automatically transferred by vacuum lift devices (sometimes called "chums") from the oven conveyor to another conveyor which moves the ware to a "finishing machine," where each piece is prepared for kiln firing.

As shown in an accompanying picture, the transfer from conveyor to finishing machine is a manual operation. It, too, could easily have been performed by automatic machinery, but the judgement of an experienced inspector at this point can not be duplicated by any known machine.

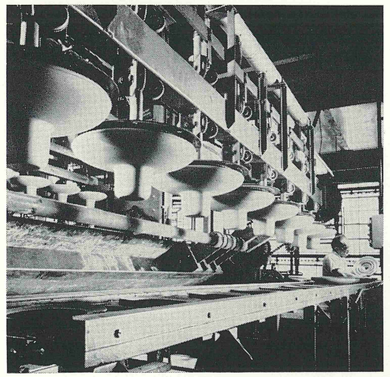
The inspector must remove each piece from the conveyor, inspect it, and place it on the finishing machine. Each piece, incidentally, is automatically marked for future identification.

The finishing machine is, in many respects, one of the most interesting parts of the entire Futura production line.

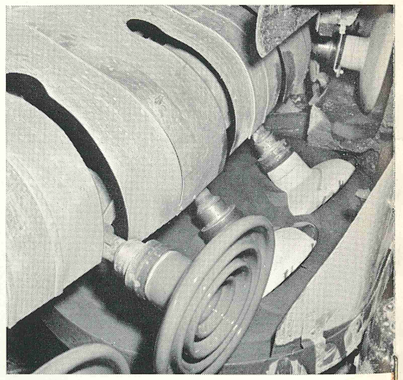
As illustrated on these pages, it takes the form of a giant wheel, approximately 25 feet in diameter, revolving slowly on an axis perpendicular to the floor. Closely spaced around the circumference of the wheel are 60 mechanical arms, each terminating in a vacuum cup "hand."

The arms are raised in a vertical position as the inspector places an insulator body on each vacuum cup. Then, in rapid succession, the insulator is spun and centered on the cup, brushed inside and out to remove any surface projections, and vacuumed to remove dust.

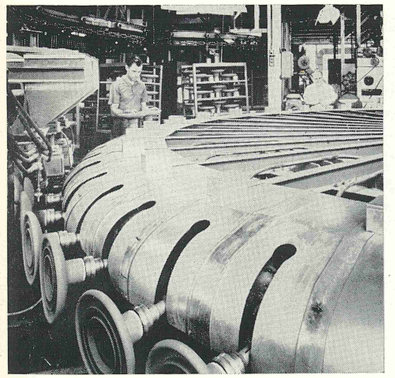
As the wheel turns, the arm then lowers the revolving piece into a constantly-agitated glazing tank where a smooth coating of glaze is applied to outer and inner surfaces and pinhole.



As insulator bodies leave the drying ovens, they are transferred by vacuum-lift "chums" to another conveyor moving toward the finishing machine. As shown here, the movement from conveyor to finishing machine is a manual operation, permitting a careful inspection of each insulator before finishing.



Close-up of the glazing operation shows how mechanical arms and vacuum-cup "hands" automatically position insulator shapes for successive operations on the finishing wheel.



Finishing machine handles 60 insulators at a time, performs a half-dozen operations preparatory to kiln firing. Inspectors examine each insulator before and after the finishing operation and record quality control data on each.

The glaze is briefly air-dried, and then head and pinhole receive a coating of specially prepared porcelain "sand" which provides a gripping surface for cement in the assembled suspension insulator.

By this time the wheel has come full circle and the vacuum cup releases the insulator so a second inspector can remove it, inspect it, and place it on an overhead carrier for movement to the firing kilns.

During the entire cycle described here, the only manual operations are the two quality control inspections before and after the finishing operation.

The really critical inspections and tests come after the insulator bodies are fired. The inspections referred to here, like those that have accompanied every previous stage of manufacture, are simply refinements demanded by the rigid O-B quality control program -- the most refined, the most rigid program of any insulator manufacturer.

Electricity sparks the '60s

As usual the committee for National Electrical Week has come up with a good theme -- ELECTRICITY SPARKS THE '60s.

Could any theme be more appropriate as we go into this new decade with its tremendous promise for the electrical industry? Everywhere we turn the password is MORE . . . MORE new family formations . . . MORE new housing units . . . MORE new electrical appliances . . . MORE money for spending to live better . . . electrically.

ELECTRICAL WORLD magazine, in its 10th Annual Electrical Industry Forecast 1959-1975, estimates that this year the average residential customer will be using 3,803 kwhr; in 1965, some 5,175 kwhr; and in 1975 about 9,374 kwhr.

The magazine also says, "It's conceivable that an industry-wide sales campaign for electric living could easily boost average residential customer use to better than 15,000 kwhr per year by 1975. In fact, there are areas today with a relatively high saturation of electrically heated homes where annual customer usage regularly exceeds 15,000 kwhr per year."

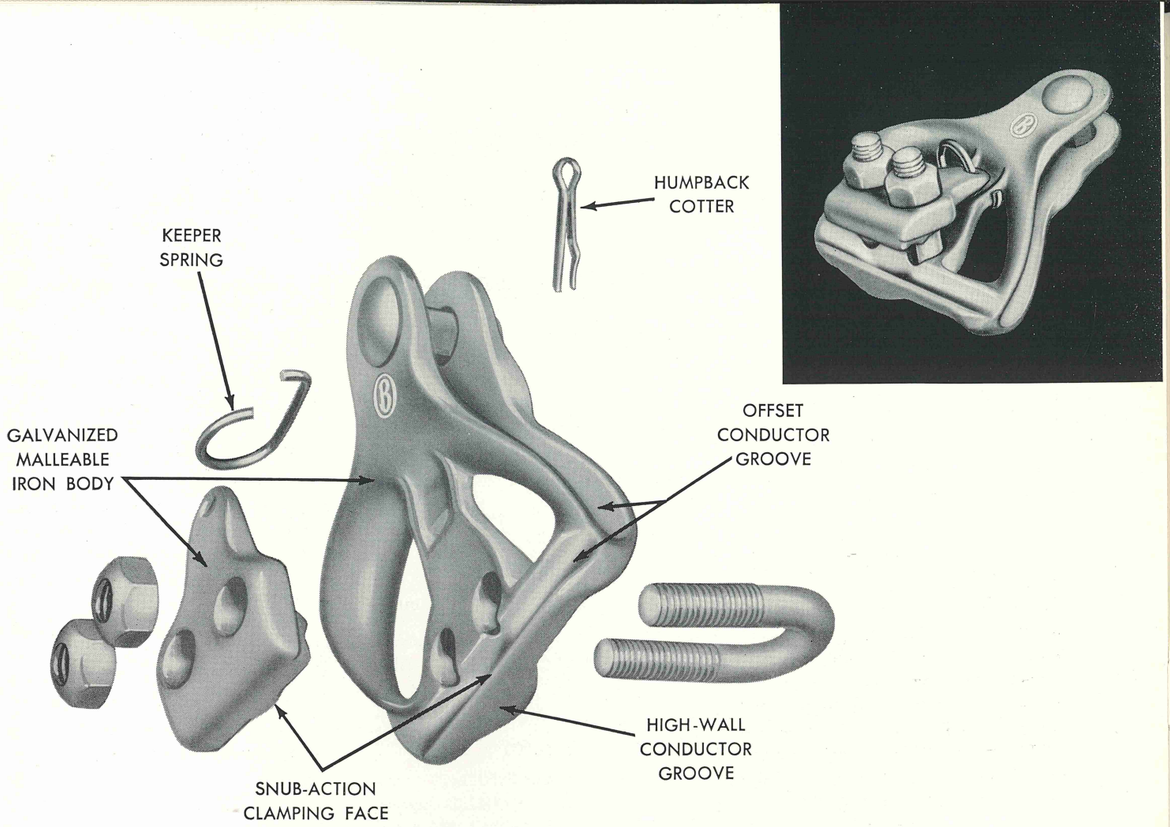
With this to look forward to, will you be ready for the increased load? Specifically, will your deadends have enough insulation to insure a line's easy conversion to higher voltage?

It's just as easy, and much cheaper in the long run, to have your linemen put in three six-inch O-B suspension insulators instead of two when installing or replacing a deadend. This will insure a reserve line insulation capacity for many years to come. Such measures will help your system be ready for the future.

National Electric Week always provides an opportunity to boost the idea of living better . . . electrically. At Ohio Brass we are wholeheartedly for electrical living and are promoting it with our employees and in the communities where O-B plants and representatives are located. We feel that even though an O-B six-inch suspension insulator is not as glamorous an item as a television set, it contributes in its own way in getting people to LIVE BETTER . . . ELECTRICALLY.

NATIONAL ELECTRICAL WEEK

FEB. 7-13, 1960



UNIVERSAL 88500 HAS NO LOOSE PARTS

spring-held keeper piece stays open while conductor is formed

The last time this Universal 88500 clamp is in pieces, as in the exploded view, is before assembly. Once it's put together, there is no need for the user to take it apart.

The advantage of this feature can be seen immediately when you visualize a lineman at the top of the pole installing an 88500. He's not fumbling with loose keeper piece, U-bolts or nuts . . . or dropping these parts to the ground and delaying the installation. He just positions the conductor in the clamp seat and tightens the keeper to complete the job.

What makes the Universal 88500 different from other clamps is the small, music-wire spring that holds the keeper piece open and in proper position until the nuts are tightened. The lineman can use both hands for forming the conductor. The clamp automatically stays in alignment, and continues to stay in alignment during the tightening operation as the lineman holds the conductor in place with one hand and tightens the clamp with the other. As a result, the 88500 is easier and faster (hence more economical) to install and maintain -- especially under hot-line conditions -- than old-style clamps.

Excellent holding strength is provided for every type of conductor between .20 and .50-inch diameter. All installation and maintenance operations can be done conveniently from one side of the clamp.

The use of malleable iron for the clamp body and keeper piece and hot-dip galvanizing of all ferrous parts assures long-time, dependable service.

The clamp is made with an especially high wall along the clamping section to retain the conductor while the keeper is being tightened. Notice, in the exploded view, the conductor groove is offset slightly to separate the slack section of conductor from span section where they would otherwise cross, rub together, and wear.

While other clamps may have one or two features found on the Universal 88500 distribution clamp, there's not one to match it for overall quality and ease of installation. Try it on your next deadending of distribution lines and you'll notice the difference, too.

HOLAN'S "BRUTE OF A DERRICK" ENGINEERED TO WITHSTAND ABUSE

Utility crews refer to the new Holan Series 3750 Hydraulic Derrick as "a brute of a derrick."

It's a term of endearment, an expression of praise, and a statement of faith in the ability of this derrick to withstand abuse in the field.

The Holan 3750 is engineered for those extra-rugged jobs. The new rectangular side legs, fabricated from long-lasting, rust-resisting, high tensile steel, are stronger than the tubular side legs used on the Series 3700 -- an earlier Holan model with an enviable record for service in the field. A sturdy cross support between the derrick legs adds strength and rigidity.

Not only is the 3750 built extra strong, but it is built extra powerful. The longer middle leg hydraulic cylinder allows the derrick head to come closer to the ground for forcing the digger deeper into the soil than was possible with the Series 3700.

The integral middle leg with live boom action provides extra power for butt-pulling and body loading transformers, cable reels or other equipment weighing as much as 5,000 pounds.

The extra power comes in handy for such tasks as forcing diggers into hard-frozen, rocky soil. And real proof-of-strength is its ability to remove an auger filled with dirt.

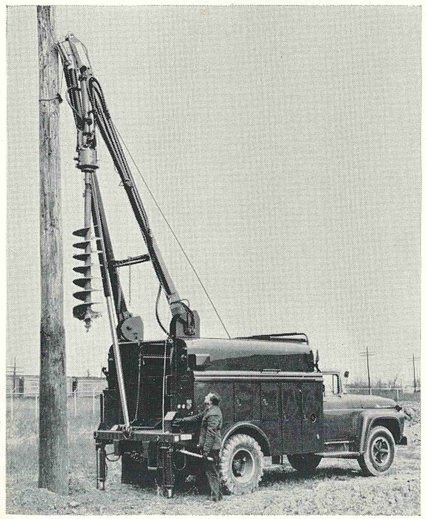
Holan specification data rate the 3750 as a 12,000-pound capacity derrick, capable of setting poles 75 feet in length. But it has actually been tested at 22,000 pounds.

Even though the 3750 is a brute for work, it can be operated with a minimum of human energy. One man raises the derrick in 35 seconds, stows it in position in 40 seconds. A super-sensitive hydraulic system with a pump driven by power takeoff controls every movement of the 3750.

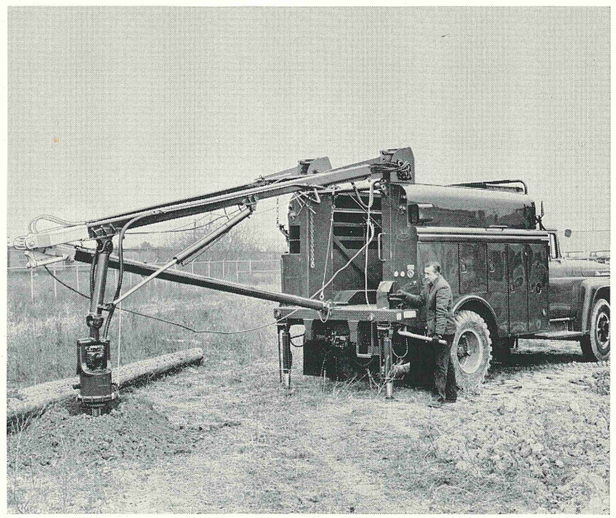
Not only is the 3750 easy to operate, but it has a working range of 195°. It swings from its over-the-cab storage position to within 5 feet of the ground for easy threading of the winch line.

For more details on this "brute of a derrick" built with extra power for the tough tasks, write Holan Corporation, 4100 West 150th Street, Cleveland 35, Ohio, a wholly owned subsidiary of The Ohio Brass Company.

Hoisting 12,000-pound loads -- the rated capacity -- is an easy job for the Holan 3750 Hydraulic Derrick. Actually, the 3750 has been tested at 22,000 pounds. This "brute of a derrick" handles 75-foot poles and body loads of 5,000 pounds.



Forcing the Holan 5400 Multiple-Speed Digger shown here into the frozen ground is made easier by the extra power of the Holan 3750 Hydraulic Derrick. This new Holan derrick lowers to within five feet of the ground for easy threading of the winch line.



THOREX PRESSURE-RELIEF SYSTEM FUNCTIONS WITHOUT HOUSING FAILURE ON 200,000 HP FAULT-CURRENT

two separate tests involving massive discharges prove safe design of venting and relief provisions

Normally, one does not pride himself on how well his product fails, but failure must be part of the design assumptions in a lightning arrester. There may come a time when there can be no alternative, and the arrester must protect a piece of valuable apparatus at the cost of its own life. In such an event, the arrester should not be a contributing source of other damage.

Two series of high fault-current tests have been run on Thorex Dynagap arresters. One of these was a field test, the other in a laboratory. Man-made conditions were required because, in actual service, the Dynagap model of Station Class Type-MPR has produced no field failures.

Purpose of both tests was to investigate the efficiency of O-B's venting and pressure-relief techniques. It has been the objective to build a lightning arrester and not a bomb. Explosive force must be dissipated safely below the housing's point of disintegration.

The field test was set-up by combining the total output of several 230-kv transmission lines, with 75 per cent of the capacity of one of the nation's largest hydro plants. This produced a fault current of 23,000-rms amperes. With offset, the crest was 43,500 amperes.

The laboratory test was still more severe. Here, a special generator, with 90 tons of rotating mechanism, was brought to a screaming stop in a few cycles. This produced as high as 46,700-rms amperes of arrester fault current. Arc voltage during fault was approximately 3,000. Since it is in phase with fault current, the result is approximately 150,000 kw or 200,000 hp. The momentary release of this energy on short-circuit is appalling.

Specimens of Thorex Type-MPR arresters were specially prepared for these tests by being assembled with laboratory-damaged parts to assure prompt failure.

In all cases, the porcelain housing remained fully intact, and its cemented assembly with the end caps was not impaired.

Factors in the design of Type MPR arresters that contribute to this performance are as follows:

(A) Venting at both ends.

(B) Diameter of vents larger than inside diameter of arrester housing.

(C) An unobstructed, straight internal passage constituting approximately one-third the inside space. This permits rapid, un-impeded migration of the pressure front.

(D) Instantaneous relief without any succession of functions. System is actuated by pressure only, in a single operating cycle.

(E) Attachment lugs on end castings at either end of the arrester are so-located as to provide adequate clearances and thus permit the escape of gasses without back-pressure.

(F) Ceramically bonded inorganic valve blocks materially reduce the amount of gas-evolving material within the housing.

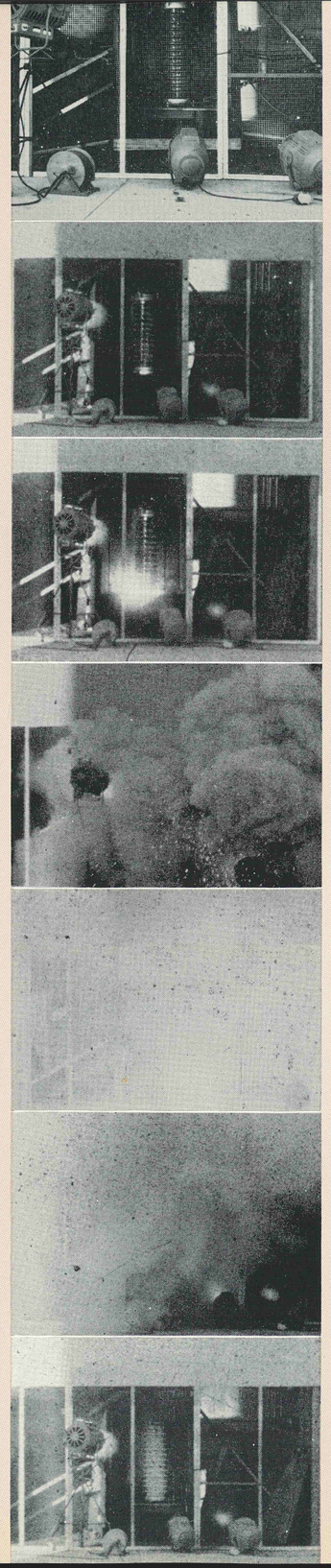
An auxiliary low-pressure-relief system is included in the Type MPR arrester for the reduction of internal pressures that may not be sufficient to actuate the main vents. In this way, there is no danger from residual pressure.

The fault current arcs are intentionally confined within the failed arrester housing so as to prevent accidental contact between the fault current arc and other circuits or circuit components. Heat of the arc might crack the porcelain in a prolonged fault, but there would be no force to propel fragments.

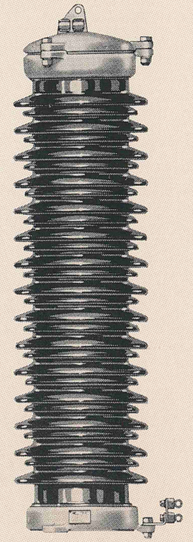
These tests emphasize one more element in the protection afforded by the Station Class Thorex Dynagap Type MPR arrester. In its normal electrical functions, no comparable device is now on the market. In the event of all-out sacrifice, the possibility of damaging surrounding equipment is minimized.

In conclusion, based upon these comprehensive tests, the pressure relief system of Type-MPR Thorex arresters can be conservatively rated at 40,000 rms amperes.

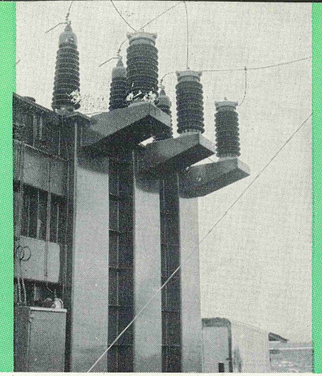
Below:
Field test on pressure-relief system. Energy for this test was obtained by combining the total output of several 230-kv transmission lines with 75 per cent of the capacity of one of the largest hydro plants. This produced 23,000 rms amperes, or a crest of 43,500 amperes with offset. The accompanying three frames from a high speed motion picture show the instant of fault initiation and relief, clearing, and the intact Thorex Type MPR arrester after test (far right). Other equipment in the picture includes additional O-B arresters which were part of the test, and stand-off insulation to support the electrical conductors. While internal elements of the arrester were reduced to cinders, no physical damage was suffered by the porcelain housing or end caps. Operation of the pressure-relief system was completely effective.



At Left:
Laboratory test under massive short-circuit. To produce energy for this test, a generator with a 90-ton rotor, and specially built for the purpose, is stalled in a few cycles on a dead short. Output of this machine was 46,700 rms amperes. Arc voltage was approximately 3,000 and in phase. Therefore the energy was about 150,000 kw or 200,000 hp. Progressive frames from a high speed motion picture film are shown; starting with the test setup, and following with the first sign of relief at the lower end of the arrester. In the final picture, the arrester "bloody but un-bowed" is still intact. It is now dust covered, but the housing and end caps remain unaffected. Men with a lifetime of electrical testing were amazed that this energy could be handled, which is a good indication of the effectiveness of Thorex Type MPR pressure-relief.



IT PAYS TO BUY THE BEST LIGHTNING PROTECTION



Three O-B Station Class arresters installed directly on a 138 kv transformer in a southern power station are closely connected to the transformer's bushings.

Guard your apparatus and circuits with O-B station class arresters

O-B Thorex Dynagap Station Class Lightning Arrester is the best protective device you can buy today. For your vital apparatus or circuits, you need the best protection to assure your customers of uninterrupted service.

Here are the characteristics that make O-B's station arrester your best protection:

- Lowest IR discharge voltage
- Quickest extinction of 60 cycle follow current
- Best long-duration thermal durability
- Best contamination immunity
- Most convenient to install on equipment

O-B Thorex arrester permits the passage of massive discharge currents without excessive voltage buildup. IR discharge and sparkover voltages are the lowest industry level and are rated in the catalog at absolute maximum values. You know exactly what you get and you know your equipment is protected with the widest protective margin available today.

Not only must an arrester allow lightning current to pass to ground in the shortest time with the least resistance, it also must interrupt the 60 cycle follow current that continues to flow after the grounding of the lightning surge. A few cycles of system energy flowing through an arrester would destroy it. Therefore, the arrester must pick off the lightning surge with incredible speed and then switch back to interrupt the 60 cycle follow current quickly. Although this is generally done at the next voltage-zero within half a cycle, O-B Dynagap does it almost instantaneously - well before voltage-zero.

The Dynagap is a series of current limiting gaps using irradiating points to start the spark and then employing a magnetic field to stretch out the arc between its "V" shaped electrodes, confining it to a progressively smaller opening between Mycalex plates. This action stretches the arc approximately 140 times its original length and at the same time cools it on the surface of the Mycalex. The major part of the arc extinction is accomplished right in the Dynagap, leaving the silicon carbide valve block with far less duty than had been previously entrusted to it.

Lightning surges are not the only over-voltages that arresters see. Surges on cables or on long high-voltage lines are generally of longer duration than lightning, and the arrester must work longer. O-B Thorex arrester has the greatest long-duration thermal durability to handle these surges because the valve blocks are not asked to overwork.

The Thorex Dynagap arrester is so durable that the recommended ASA low-current, long-duration withstand test for lightning arresters must be increased to test them effectively. The ASA test of station arresters calls for 150 ampere current for a duration of 2,000 microseconds. The test wave is applied a total of 20 times over a period of 75 minutes, allowing a one-minute cooling period between shots, and 15 minutes cooling between each group of four shots. The O-B modification increases the current from 150 to 1,000 amperes for 2,000 microseconds and does not provide any cooling periods. The total test is run in 6½ minutes instead of the 75 minutes allowed by ASA.

This O-B test shows the new order of durability incorporated into each Thorex station arrester - durability that will meet today's service requirements.

Another Thorex station class feature for modern requirements is the one-piece porcelain housing. Without any inter-unit connections, the O-B station class arrester is free from potential damage from leakage currents over contaminated surfaces. Regardless of the severity of the contamination problem, the arrester's protective circuit cannot be exposed to leakage currents at any point.

Reduced height of the station class arrester permits manufacture of porcelain housings in one-piece, thus eliminating the need for unit stacking to obtain a given voltage rating. This simple method removes the *cause* of contamination damage and allows the arrester to be hot washed just like station insulation.

A one-piece arrester is easily installed. It can be mounted directly on the apparatus, within or on the station steelwork, base-mounted or cap-mounted. Mounting can be arranged to use the shortest possible leads to the protected apparatus. The Thorex arrester is no taller than other insulation of the same voltage class. No costly provisions for installation are required; just a crew of two and a light hoist can install even the largest unit, 115½ inches tall, 1050 pounds, for 345 kv service. The savings on installation alone can go a long way toward the purchase of these modern, heavy duty station class lightning arresters.

6183-H Printed in U. S. A.

HOLAN
HI-TENSION NEWS DEC., 1960

1.

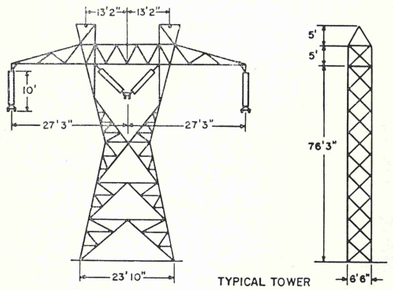
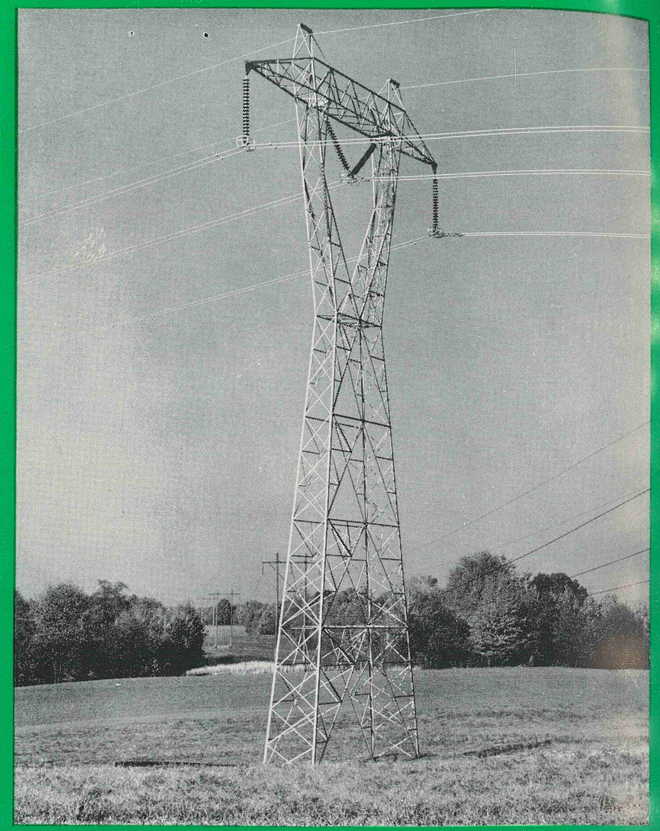


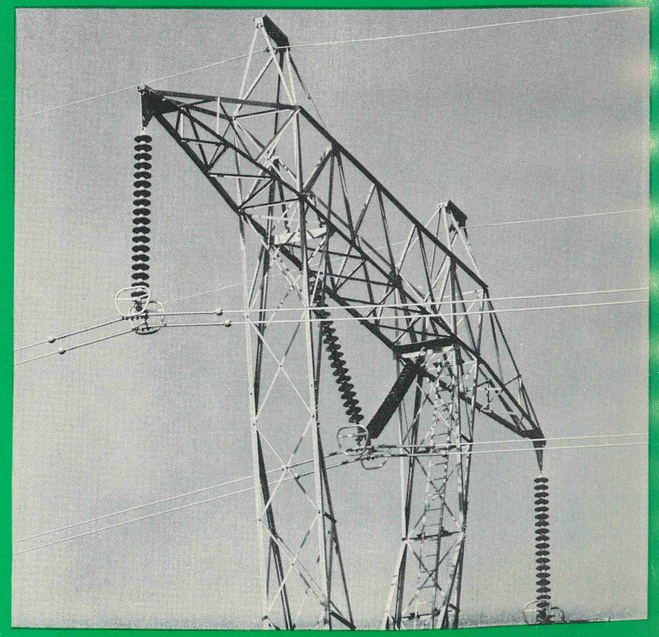
Figure 1. Dimensioned sketch of Ohio Edison narrow-base 345-kv tangent tower. Horizontally-bundled conductors sharply reduce probability of broken-conductor loading, permit very economical tower design. Angle towers and deadends have broad, square base.

Figure 2. Dimensioned sketch of outside phase insulator assembly, showing detail of lower end hardware and shielding rings.

Figure 3. Center phase V-string assembly.

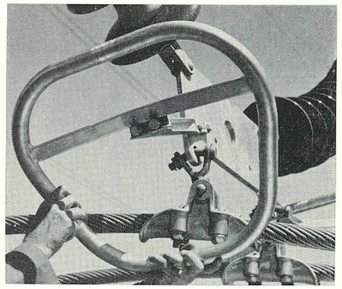


(Upper right) Typical narrow-based tangent tower on Ohio Edison 345-kv line.

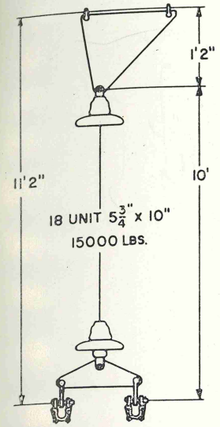


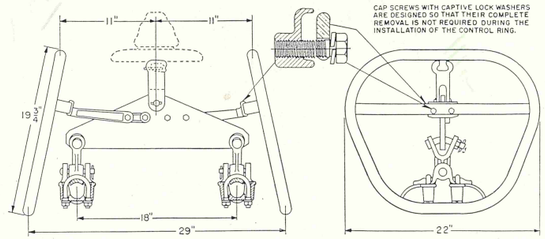
(Lower right) Close-up of insulator assemblies on tangent tower.

Side view of shielding ring. Ring can be lifted off assembly under hot line conditions simply by loosening two bolts.

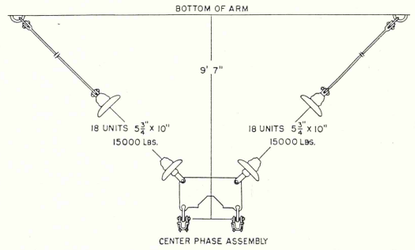


2.





3.



BUILDING FOR TOMORROW ON EHV

Ohio Edison's newest 138-kv transmission lines designed to carry 345-kv in near future

Ohio Edison Company, which serves 585,000 customers in central and northeastern Ohio took a giant step forward this year with the completion of two long-planned 345-kv transmission lines.

With a total generating capacity of approximately 1,900,000-kw (soon to be increased as described below), the company operates a total of 3800 circuit miles of 23-kv and above, including an extensive network of 69-kv and 138-kv.

The eastern end of this network interconnects with a subsidiary, Pennsylvania Power Company, which has a generating capacity of 268,000-kw and serves 88,000 customers in western Pennsylvania.

The two companies constitute what is called the Ohio Edison System.

The cities served by Ohio Edison include Akron, Barberton, Alliance, Ashland, Lorain, Elyria, Mansfield, Marion, Massillon, Sandusky, Salem, Springfield, Warren, and Youngstown. Those served by Pennsylvania Power Company include New Castle, Sharon, Farrell and Greenville.

And while the power needs of these major communities are constantly increasing, so too, are the needs of the company's residential customers. In 1959, for example, the average use of electricity per residential customer on the System was almost five per cent more than in 1958.

Overall, the company sold 14% more kilowatt-hours in 1959 than in the preceding year.

To keep ahead of this swift rate of growth, and to insure maximum economy and efficiency in operations, Ohio Edison -- like other forward-looking utilities -- is investing in larger generating units and in transmission networks capable of handling its output in larger blocks of power.

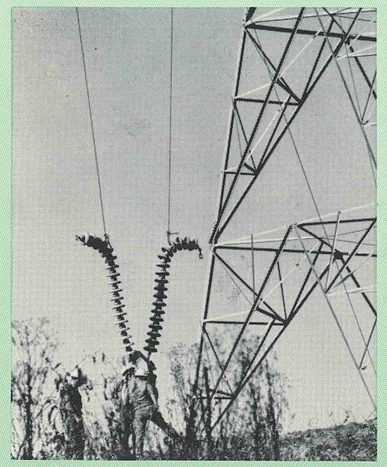
In August of 1959 the first of four 173,000-kilowatt generating units went into commercial operation at the Company's new steam-electric power plant at Stratton, Ohio, on the Ohio River.

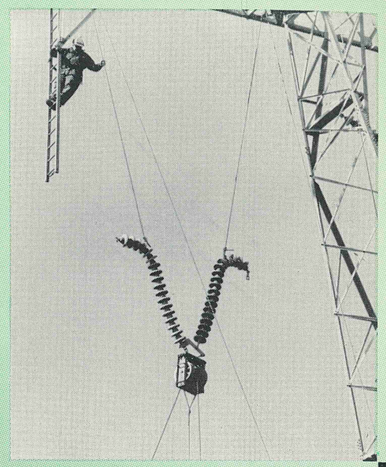
In July of this year, a second generator of similar size went into service. A third unit will be added next year; a fourth in 1962.

Total output of the four units will be 692,000-kw -- accounting for over 25 per cent of the total capacity of the Ohio Edison System's 11 generating plants.

Three transmission lines, designed to operate at 345,000 volts, will carry Stratton power to load centers in the utility's service area. One line extending from Stratton to a substation near Warren, Ohio - a dis-

installation of V-string insulator assembly in "restrained pull-off" position on angle tower





tance of 48 miles - was completed in the spring of this year. The first of two lines to terminate at a point midway between Barberton and Wadsworth, Ohio, 69 miles in length, was also completed this year. This termination point is about seven miles west of the O-B Barberton plant.

Early in the design stage, the decision was made to use single circuit steel towers as light as possible, but still adequate for the loading to which they would be subjected, with horizontal conductor configuration. (Figure 1.)

Use of twin-bundled conductors (954 MCM ACSR on 18-inch centers) resulted in a tower design that did not have to take broken conductors into consideration. The probability of simultaneous failure of both conductors in the same span could be accepted as a very small calculated risk.

In order to study the behavior of the bundled conductors under icing, broken conductor, and vibration conditions, a 1¼-mile test line was constructed. (This was later incorporated as a part of one line.) Tests on this line also permitted accurate evaluation of all mechanical components, such as insulators, supporting hardware, clamps, armor rods, and spacers.

(Results of the tests made by O-B and Ohio Edison engineers were reported in AIEE Paper No. DP 59-562 -- available from AIEE headquarters.)

The outside phases of the insulator assembly and the center phase V-string assembly are shown in the accompanying pictures.

The V-string support of the center span stabilizes the conductor against sway, affording closer phase spacing, reduced tower width, and narrower right-of-way -- as well as the inherent electrical advantages of closer phase spacing.

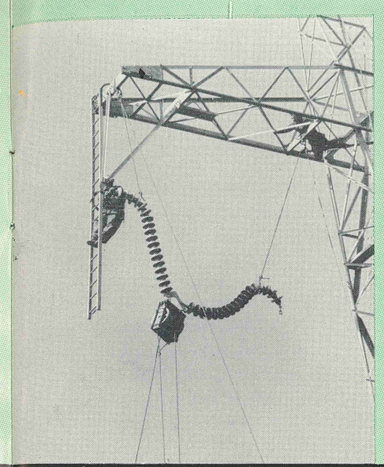
Angle towers, as shown in an accompanying picture, use a "restrained pull-off" on all three phases by means of V-strings. It will also be noticed that angle towers have a broad, square base rather than the narrow profile of the tangent towers.

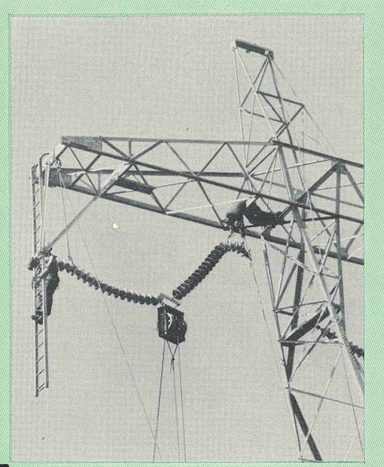
An interesting feature of the Barberton line is the use of shielding rings on approximately one-half of its length. This installation is being made to determine whether shielding rings are necessary. The design created by O-B engineers permits ready access and removal even under hot-line conditions.

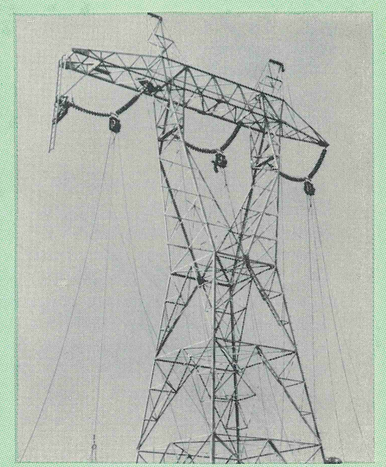
Both the Barberton and the Warren line were energized at 138-kv in the spring of this year.

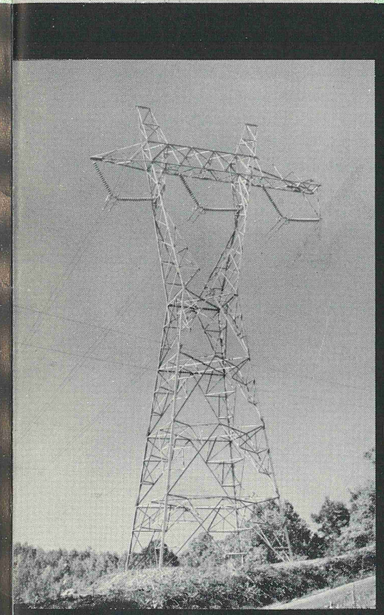
The Barberton line will go to 345-kv in 1962 when the fourth generating unit goes on the line at the Stratton plant. The Warren line will not carry the higher voltage until several years later.

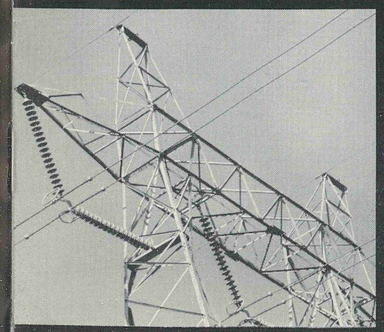
Ohio Edison, thanks to far-sighted planning, is thus a step ahead of today's requirements -- and a giant step closer to the economy and efficiency of tomorrow's extra-high voltage systems.





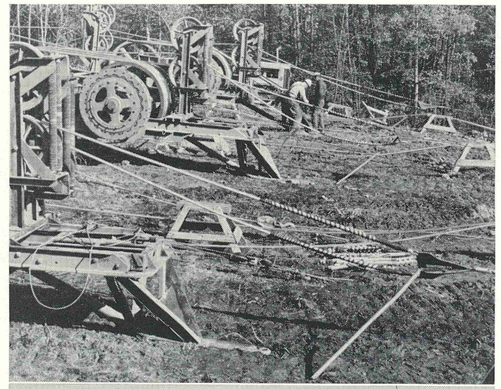


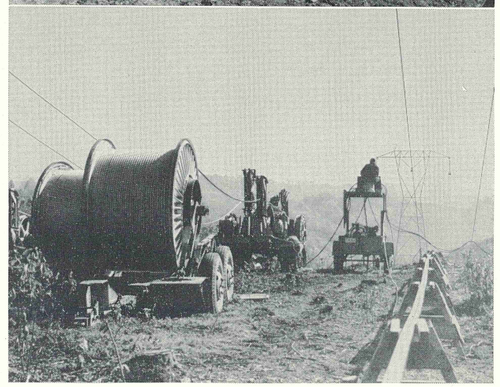




(Above right) Angle tower has a broad square base. V-strings effect "restrained pull-off" on all three phases.

(Right) Close-up of insulator assemblies on angle tower.





Three phases were strung simultaneously under tension.

WANT TO SAVE MONEY ON LIGHTNING ARRESTERS?

check the performance of the Thorex GP arrester; its protective ability may be just what you need

Performance of today's Thorex GP Intermediate Class arrester exceeds the performance of all lightning arresters up to 1956, regardless of price or class. If your station was built prior to that time and was provided with even the best arrester available then, you can replace the arrester with O-B's Series III GP Intermediate Class and be sure that you will get equal or better characteristics and durability.

Thorex GP Intermediate Class performance, unexcelled in its class, is shown by easily passing tests more severe than prescribed by ASA. The O-B low-current, long-duration durability test subjects the O-B Intermediate Class arrester to 500 amperes for 2,000 microseconds. This is nearly seven times the magnitude of current for twice the duration required by the ASA test. Compared with the ASA test for station class arresters, the O-B test for Intermediate Class arresters employs three times the current, the same duration, and is accomplished in only 1/10th the allowable test time. Relate this test to heavy surge currents and the great durability of the Thorex arrester becomes obvious.

Thorex Intermediate Class arresters easily pass the 65,000-ampere, high-current, short duration withstand test as specified in ASA Standard C-62.1. The test simulates a direct, high magnitude, short duration, lightning discharge and calls for two applications of a 5 x 10 microsecond impulse wave of 65,000 amperes. Field studies show that a typical station-located arrester may expect a 65,000 ampere stroke once in 4,000 years (AIEE Paper 51-190).

The ASA Duty Cycle test demonstrates the ability of the arrester to divert impulse surges while 60-cycle rated voltage is applied. The Thorex Intermediate Class arrester is tested by a 10,000 ampere 10 x 20 microsecond impulse wave twice the 5,000 amperes specified. Oscillograms taken during the tests clearly demonstrate the ease with which the Thorex arrester can pass the test. Extinction of 60 cycle follow current is performed well in advance of voltage-zero - an ability unique with Thorex Dynagap.

The superior performance of O-B Intermediate Class arresters is reason to consider them for jobs in your stations. In selecting O-B Intermediate Class lightning arresters for new application, the following points should be considered:

For voltages up to 34.5 kv the Thorex Intermediate Class arresters have single unit housings and are not subject to damage from leakage currents over contaminated surfaces. Above 34.5 kv, the arrester is a multi-unit assembly and will perform with little or no attention. For excessive contamination areas, best judgment dictates the use of the Thorex Station Class with its one-piece porcelain housing.

Thorex Intermediate Class arresters exceed all other intermediate class in thermal durability because of their quick extinction of the 60 cycle follow current arc. This arrester stands up well under repeated lightning surges, switching surges and other system disturbances. If surges are severe, the Thorex Station Class arrester with its even greater durability can deal with them better.

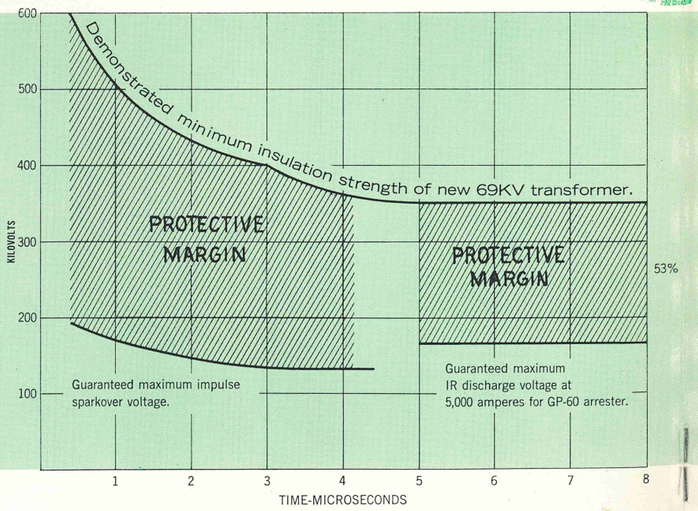
Available fault currents should be considered even though arrester failures are not expected. Because of its pressure relief system, a laboratory-failed Thorex Intermediate Class arrester has survived, intact a 20,000 ampere fault current. Should a condition exist or should there be such a location that a fault current in excess of 20,000 amperes might reach a failed arrester, the Thorex Station Class arrester should be used.

To sum it up, if you want to save money on lightning arresters and you have been uncertain about the protective ability of industry's intermediate class arrester, you can now choose O-B Thorex Intermediate Class with confidence. It is clearly a superior type in its class.

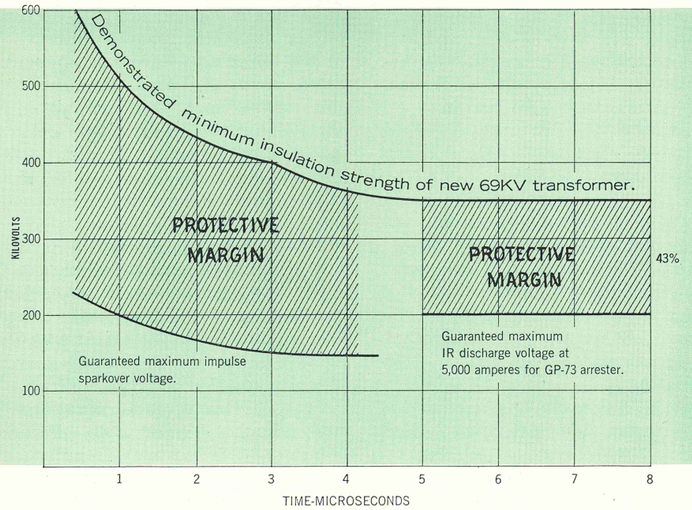
Several years ago, you probably would have specified "station class" arresters without question for installation on an older transformer of unknown insulation integrity. Today, you can specify "Thorex Intermediate" because it is equal or better in protection and durability than the best that was available only a few years ago.

Are you designing new stations -- with budget problems and a need for adequate protection? Specify O-B Thorex Intermediate Class arrester and you will get the most for your arrester dollar.

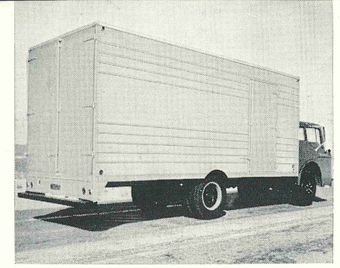
These graphs illustrate the excellent protection afforded 69-kv class transformers by Thorex Dynagap Intermediate Class lightning arresters. The percent protective margin is found by dividing the kv of protective margin by the minimum BIL of the transformer. Both the 80% and the 100% arrester applications are calculated at the maximum IR discharge voltage with lightning currents of 5000 amperes. For illustrative purposes we have assumed the transformer to be new; however, the age or service condition of the apparatus may place the actual insulation strength below the minimum test levels. Since the true level of apparatus insulation may not be known, it is essential that the arrester provide a wide protective margin. Thorex Dynagap lightning arresters give the widest margins of protection available in each arrester class.



Application of 80% arrester (Thorex GP-60) to a transformer on a 69-kv effectively-grounded neutral system.



Application of 100% arrester (Thorex GP-73) to a transformer on a 69-kv ungrounded neutral system.



O-B BUYS DENVER TRUCK-BODY, TRAILER MANUFACTURER

acquisition provides more Holan service facilities for West

The Ohio Brass Company has purchased the assets of Timpte Bros., Inc., Denver manufacturer of special over-the-road trailers, semi-trailers, truck bodies, and special trailers.

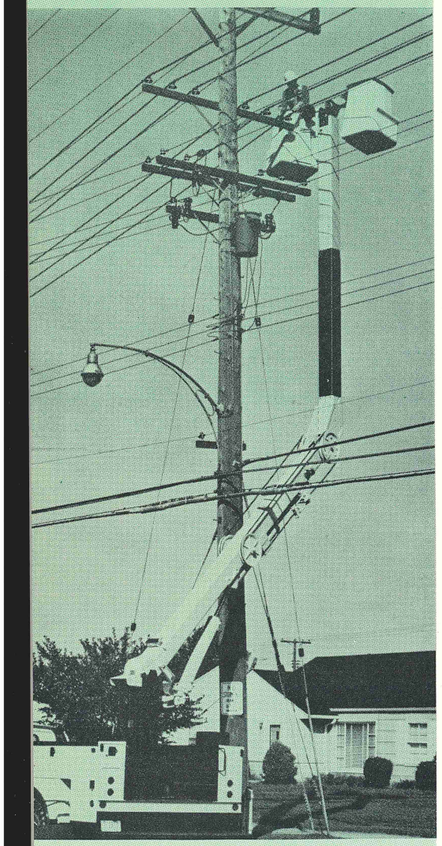
The company will be operated as a division of Holan Corporation, a subsidiary of O-B, and will be used for building Holan equipment as well as providing diversification.

Timpte products will supplement and expand the line of special truck bodies and truck-mounted power devices which Holan Corporaton makes for the utility field.

Acquisition of Timpte Bros. of Denver and its Albuquerque, N. M. manufacturing and service center will give Holan Corporation additional western bases for manufacture and sale of products to the West Coast and Central States areas. Present manufacturing facilities of Holan include Cleveland, Griffin, Ga., Phoenix, Arizona and Niagara Falls, Ontario.

To more than double present capacity, the company has under construction a new 150,000 square-foot plant and office on a 20 acre site in Denver. Further expansion is planned in the western area for assembly, sales and service facilities for both Holan and Timpte products.

Holan Elbow users report savings up to $33,000 a year



Holan's "unlimited-action" Aerial Elbow cuts a minimum of 40 minutes from the time needed to change a pintype insulator in a situation such as this. A "limited-action" aerial lift could not reach the working position while parked at the curb, so a lineman - climbing to the insulator - would spend at least 50 minutes installing and removing the necessary protective rubber equipment.

PROFIT IN AERIAL WORK? . . . IT'S A MATTER OF DEGREE

Savings of up to $33,000 a year have been reported by users of the Holan Elbow. There are several reasons such large savings can be realized by using this precision-built aerial lift, but one of the prime reasons is the wide degree of boom action available with the Elbow.

For instance, take the situation shown in the picture. A "limited-action" aerial lift -- one with less than 120° action in the lower arm and less than 270° action in the upper arm -- could not reach the desired working position with the aerial lift truck parked at the curb. And often it is impossible to park the unit any place except on the street.

But Holan's Aerial Elbow . . . parked at the curb . . . puts the crewman in position to change the insulator on a 4340-volt feeder. In order to do this, the Elbow has lifted him to the property side and above (1) telephone communication cables, (2) fire alarm circuit, (3) secondary, (4) transformer installation, (5) 2400-volt distribution, (6) series street light circuit.

At least 40 minutes can be saved using the "unlimited-action" Holan Elbow here. A lineman climbing the pole would have spent a minimum of 50 minutes installing and removing protective rubber equipment. With the Holan Elbow, rubber equipment is unnecessary, and the crewman could have been positioned for work . . . and returned to the ground . . . in less than 10 minutes.

So savings really became a matter of degree. Limited boom action means limited use -- and that, of course, limits the amount of savings a utility can hope to make when using an aerial lift. Both booms of the Elbow -- upper and lower -- provide all the action needed to assure the ultimate in savings.

There are many other reasons why the Holan Elbow is able to slash great sums of money from utility construction, repair and maintenance bills. The use of the Elbow -- with its 360° continuous rotation in either direction -- as a derrick is a good case in point. This rotation permits use of the Elbow as a derrick in any number of positions without moving the truck. And it can lift 6,000-pound loads, set 65-foot poles.

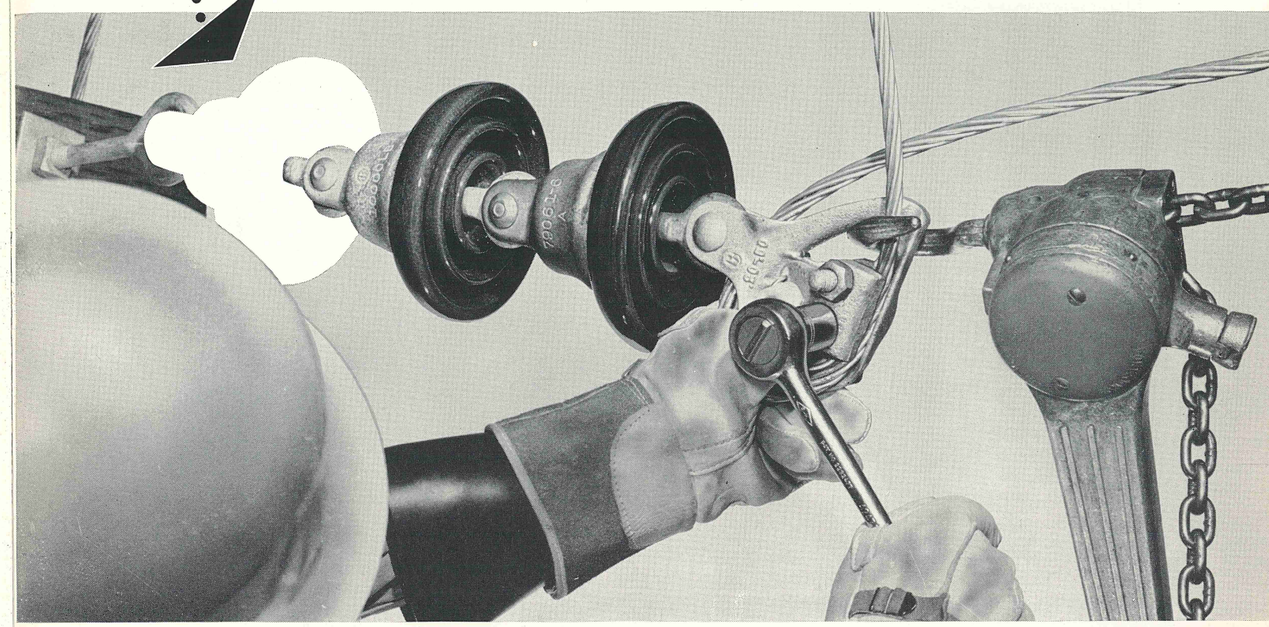
Patented cable controls that permit positive (⅛-inch at a time) positioning and exclusive bucket positioners reduce maneuvering and save crew time.

Savings with safety is the goal of every utility and on this score, too, the Holan Elbow rates tops in the field. In a strength test, the fabricated welded square tube arms of hi-tensile steel and the reinforced plastic structural member inserted in the upper arm have a minimum safety factor of 4 to 1. Because of the superb upper arm insulation, the Holan Elbow withstands a one-minute 100,000-volt bucket-to-ground test. Fiberglass-reinforced plastic rods inserted in the valve control and leveling cables, along with the upper arm insulation, prevent metal-to-ground electrical contact. Further assurance of safety is the testing of the non-conductive fiberglass buckets. They must withstand a 50,000-volt (a c) test before they are mounted on a Holan Elbow.

For a greater degree of savings and safety, call your Holan Field Representative -- or write Holan Corporation, 4100 West 150th Street, Cleveland 35, Ohio, a wholly owned subsidiary of The Ohio Brass Company, for complete details.

. . . AND ONE TO GROW ON

an extra unit in a distribution dead-end can repay 50 times its cost!



How many times have we heard this . . . "If I had spent only a couple of dollars a few years ago, it would have saved me a hundred!".

Very few men in the distribution end of the power industry can see no possible chance for a primary voltage increase in the next ten years. Most of them would hesitate to make a prediction for three to five years.

When this time comes, transformers can probably be used with re-connection. Conductors will doubtless serve. Unless originally purchased to an absolute minimum level, line insulation will carry the higher voltage. But what about the deadends?

If deadends were built only up to previous voltage requirements, more insulation must be inserted. This will add at least five inches to the length, which will necessitate re-tensioning the span. The jumper loop must also be re-built. Perhaps the work will be done with the circuit energized, calling for hot line practice. Put your own cost on the job of tying-up a truck and line crew for anywhere from one to three hours. And then remember it could all have been avoided if that extra insulator had been installed when the deadend was originally built. This would have been a matter of a couple of dollars -- then.

During the time when the extra unit was not essential, it would have provided better impulse insulation at the deadend point, and would have been ready for a voltage increase without demanding another penny of expense, or causing a minute's delay in the conversion program.

In the light of broad experience and many a conversation, we never made a more honest recommendation than this: Build deadends for the future when it's cheap. When specifying insulation, add "one to grow on."

can malleable iron . . . THE METAL . . . contribute anything to

TRANSMISSION LINE HARDWARE?

Unique combination of properties provides adequate strength backed by natural safeguards

Aluminum strain and suspension clamps have been discussed in a recent issue of Hi-Tension News, emphasizing possible power savings through their non-magnetic property.

Malleable iron, used in comparable designs, likewise has its own list of advantages. The user of transmission line hardware can assign his own preference. Either metal is available in practically the entire line of O-B materials.

Probably the prime characteristic of a clamp, especially the strain type, is strength. Malleable iron is a strong metal -- not wholly comparable to certain steel alloys, but lending itself admirably to the design of hardware by the simple process of putting the right amount of metal in the right place. More important, this strength has natural safeguards that make malleable iron somewhat unique.

To dismiss the question of strength, alone, let us say you can put all you want into a malleable iron clamp. Adequate strength is only a matter of knowing what is needed and designing to this requirement. O-B clamps in malleable iron meet all industry standards with exceptionally generous safety factors.

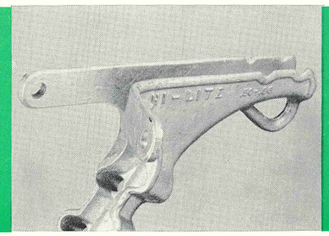
But, what about the safeguards which were mentioned? Ductility of malleable is almost unbelievable in a cast metal. A test specimen in the form of a rod, for example, can be wrapped like a spring over a mandrel almost the diameter of the rod itself. Clamps have been returned to us where clevis holes have been elongated nearly 50 per cent without metal failure, indicating its ability to stretch when subjected to excessive load. Under unexpected forces of twisting, bending, or stretching, as well as sudden shock, malleable iron has notable resistance to failure. This characteristic of high ductility is added to its basic strength, and fights a long, bitter "delaying action" where ultimate failure is imminent.

To the designer, malleable iron has some distinct advantages. In a molten state, it is etremely fluid and will fill-out the most complicated mould. This is quite unlike certain other metals. Therefore, shape of a product is rarely penalized by the ability to cast it, where malleable iron is used. In this connection, severe compromises are sometimes imposed by the forging process.

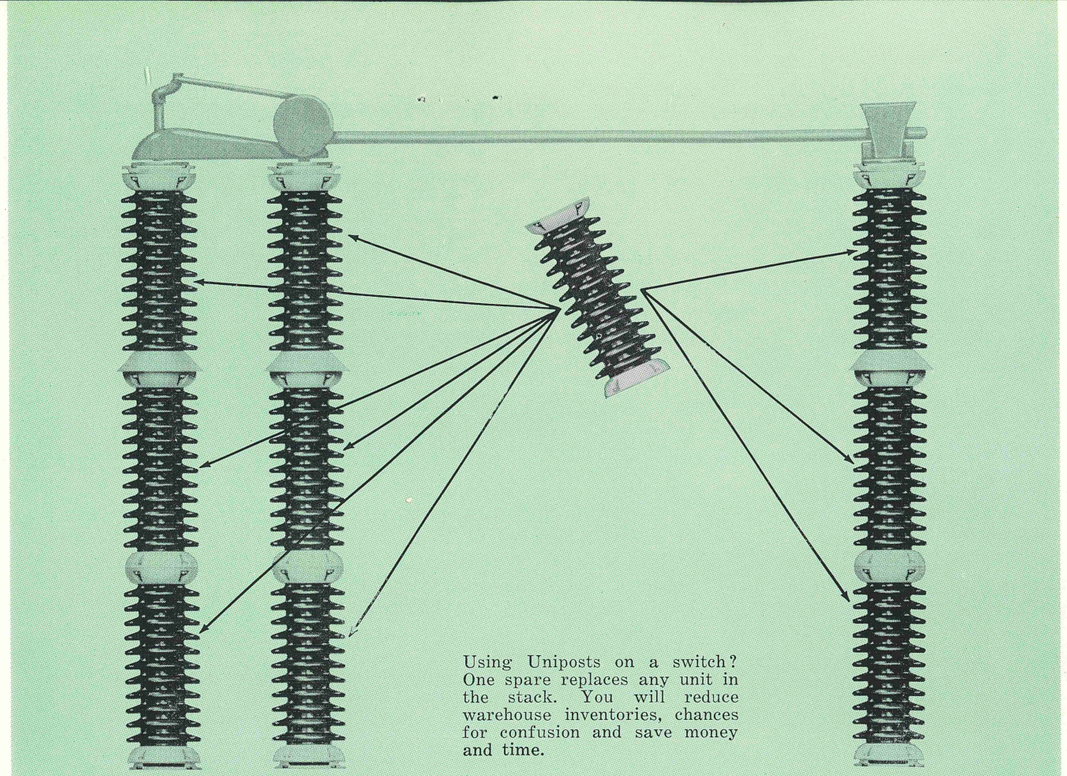
Assuming good techniques and foundry control, malleable iron is extremely consistent. When high dependence is placed on a single unit of production, such as a strain clamp, this is very important. Though careful, individual inspection is imposed on every clamp, it is far more valuable that the product have inherent reliability.

The question has been asked countless times, "Why does Ohio Brass cling to malleable iron in its line of ferrous hardware?". This question must be answered in the light of a significant fact. We have free call on any metal-making process and can take a non-partisan view of the whole subject of hardware. Having observed the performance of all kinds of hardware for many years -- and having no limitations to prejudice our viewpoint - it's still malleable!

On tensile test, at 25 per cent above published ultimate strength, one clevis connection of this clamp failed. The intact hole has been stretched almost ¼-inch out of round. This is a graphic demonstration of the elasticity of malleable iron as used in O-B hardware.



Clevis section of a malleable iron Hi-Lite strain clamp with one arm bent 90 degrees on a tight radius. Aside from a hairline crack in the galvanized coating, the clamp is still sound. This piece, and the one shown after tensile test, were selected at random from a warehouse bin



Using Uniposts on a switch? One spare replaces any unit in the stack. You will reduce warehouse inventories, chances for confusion and save money and time.

O-B UNIPOSTS ARE INTERCHANGEABLE

same unit used in all positions in stack: top, bottom, and intermediate

The O-B Unipost is a new stacking post insulator that is universal - one unit fits anywhere in the stack of a given mechanical and electrical rating. No specialized insulator is needed for top or bottom positions.

O-B Uniposts are produced in three strengths to meet the industry's requirements: standard, high and extra-high strength. In the line of Uniposts is a complete selection of BIL ratings so that whatever BIL is chosen, there will be a post or combination to meet the requirement.

Being interchangeable, the Unipost uses the same bolt circle for intermediate flanges, top or bottom mountings. The two Uniplates that accompany each stack of Uniposts adapt the insulator bolt circle to the standard drilling of the switchgear, support or framework. Thickness of the plates is included in the overall height of the insulator stack. So that when replacing older stacks, the Unipost stack will fit right into place.

If you're contemplating new installations, you may omit the Uniplate and take advantage of the slightly reduced stack height and the full bolt circle.

The Unipost is an important factor in keeping down your station post inventory, perhaps reducing it by two thirds. For instance, look at the switches requiring 1050 kv BIL insulation. They are normally supplied with three insulators per stack, three stacks per switch. That's 27 insulators for three switches. Carry a spare insulator? That's all you would need with O-B Unipost - just one, not three each for the top, intermediate and bottom positions. A Unipost fits anywhere in the stack. Less money tied up here means more for other important jobs.

Besides helping to hold down inventories, the Unipost will avoid confusion in your warehouse since there is only one unit to handle. At the job site, repair or construction will go smoother without the confusion of "which unit goes where."

If you have stacking posts or contemplate using them and you would like to save time and money, specify O-B Uniposts.

OHIO BRASS MANAGEMENT REPORT

HOW HOLAN HELPS LINEMEN SHED THEIR SPURS

BY GEORGE L. DRAFFAN
CHAIRMAN, OHIO BRASS COMPANY

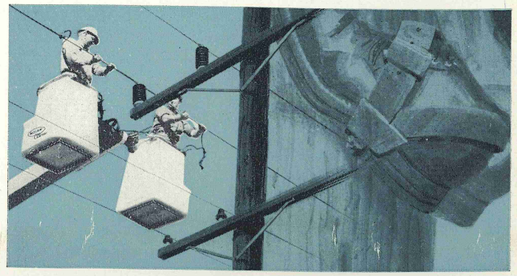
"Moving people up and down," "saving money for utilities," or "helping linemen shed their spurs" . . . these are among the many descriptions that I've heard for the over-all purpose of equipment made by Holan Corporation, O-B's wholly owned subsidiary.

A FEW YEARS AGO the only way for a lineman to get to the top of a utility pole was to climb. Now he can leave his climbers or "spurs" on the truck, step into a fiberglass bucket at ground level, pull a lever and "propel" himself as high as 85 feet in a few seconds. The minutes saved by using such aerial devices can be compounded into hours and into thousands of dollars of annual saving.

THIS IS AN INDIRECT WAY of approaching the merger almost three years ago of the J. H. Holan Corporation into The Ohio Brass Company. At that time we said the change would bring utility customers benefits in stability, flexibility and convenience. What has happened?

CERTAINLY, WE ARE PROUD of spectacular developments like a squirt boom or the insulated aerial lift that enables linemen to work barehanded on voltages as high as 138 kv. But probably of greater interest to you is the stability—financial, engineering, manufacturing, selling, servicing—that the merger has meant for the Holan operation. This kind of equipment must be backed by a stable organization.

TEN YEARS AGO the average cost of a piece of equipment sold by Holan was $4000. Today it's



$14,500. Increases in material and labor account for only a small fraction of the difference. Line bodies are about the same. The big change has come in new and more sophisticated mechanical devices—aircraft type controls, telescoping booms, high-powered diggers, complex gear mechanisms, and greater use of hydraulics. These features cost more initially. But they reduce the work-load, and cost less over the years.

THE MERGER has enabled Holan Corporation to develop the overall stability that you expect from a supplier of this equipment. It provided capital for acquiring subsidiaries that make key components, and for expanding manufacturing and service facilities. Holan equipment is now made in Cleveland, Denver, Griffin, Ga., and Niagara Falls, Ontario. It is serviced from six locations, and more will be added.

SO WE DON'T BELIEVE it's enough to offer aerial devices that promise spectacular savings in work-load today. We want to make sure you still realize these savings ten years from today. Holan offers the service that makes it possible.

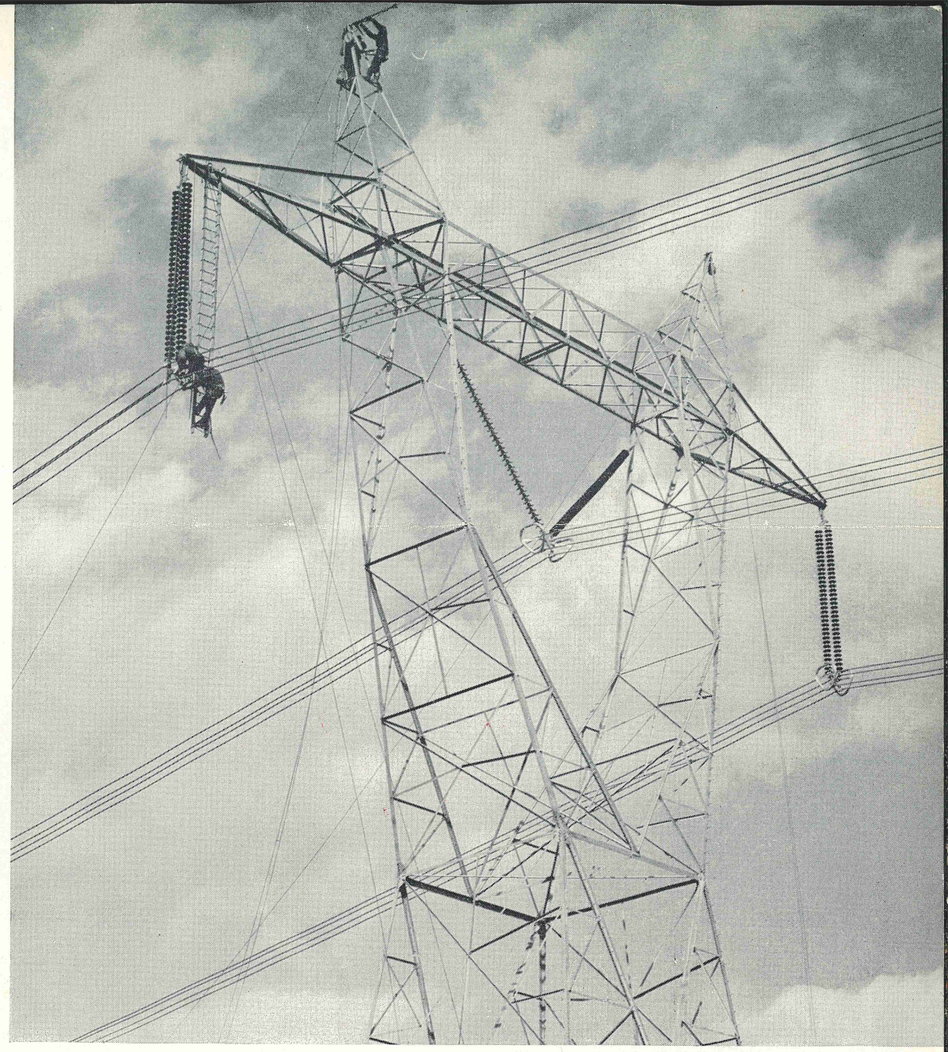
AT THE MOMENT it seems like pure fantasy, but the day may come when the lineman can hang up his climbers for good. And when ten years later the new man sees them hanging on the wall and asks "what are those?", the oldtimer can answer: "Well, believe it or not, there was a time when we had to climb poles."

HOLAN

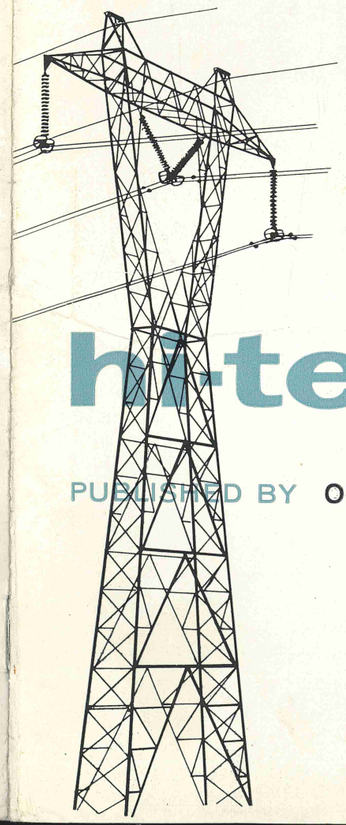
10149-H
OHIO BRASS COMPANY, MANSFIELD, OHIO
Porcelain Insulators — Line Hardware — Capacitors — Lightning Arresters
Bushings — Holan Truck-Mounted Power Devices and Bodies — Bronze Valves

6232-H Printed in U. S. A.

RECEIVED
JUL 12 1961
MANAGER
MARKETING



Apple Grove project energized at 750-kv (see page 2)



hi-tension news

PUBLISHED BY OHIO BRASS COMPANY, MANSFIELD, OHIO Vol. 30 No. 7

To: Bob
From Carl.

INSULATOR DEPARTMENT
GENERAL ELECTRIC COMPANY
P. O. BOX 10583
700 TUCKASEEGEE ROAD
CHARLOTTE , NORTH CAROLINA

HOLAN

JULY 1961

building for tomorrow on EHV

APPLE GROVE PROJECT ENERGIZED AT 750-kv

three test lines will reveal performance of three different conductor arrangements under identical atmospheric conditions

Apple Grove is a wide spot in State Route 2 as it winds southward between boulder-strewn West Virginia hills on the one side, muddy banks of the Ohio River on the other.

The site lies 14 miles south of Pt. Pleasant, Ohio, where the Kanawha joins the Ohio -- and some 200 miles downstream from an earlier AEP test site, the now famous Tidd project at Brilliant, Ohio.

Historically, these two projects lie even further apart, for the 15 years between them span the modern history of extra high voltage transmission.

When the Tidd experiments began in 1946, the EHV experience of the entire continent could be summed up in the ten-year-old 287-kv line between Boulder Dam and Los Angeles. The first 345-kv line was still seven years in the future.

In 1961, as Apple Grove begins probing the frontiers of transmission at three-quarters of a million volts, there are more than 6,000 circuit miles of EHV transmission in operation at up to 362-kv in this country and Canada.

The extraordinary accomplishments of this 15-year period would have been difficult without benefit of Tidd . . . Leadville . . . Coldwater . . . Penelec . . . and other less widely publicized experimental lines.

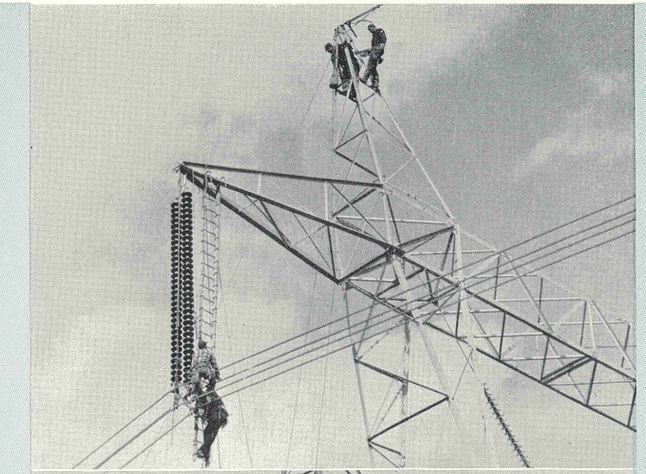
And future progress depends, in equal measure, upon continuing experimentation along the same frontiers.

Like Tidd, the Apple Grove project consists of three three-phase, open-ended test lines. The three lines run north (test line "A"), east ("B"), and south ("C") from a central test substation -- forming a "T" -- with the square-shaped station at the junction of the three legs (See Sketch A).

The north and south lines run parallel to the Ohio River, which flows due south at this point -- less than a stone's throw from the test station. (Before construction of the upstream Gallipolis roller dam, the Ohio River covered almost the entire test area at flood stage.)

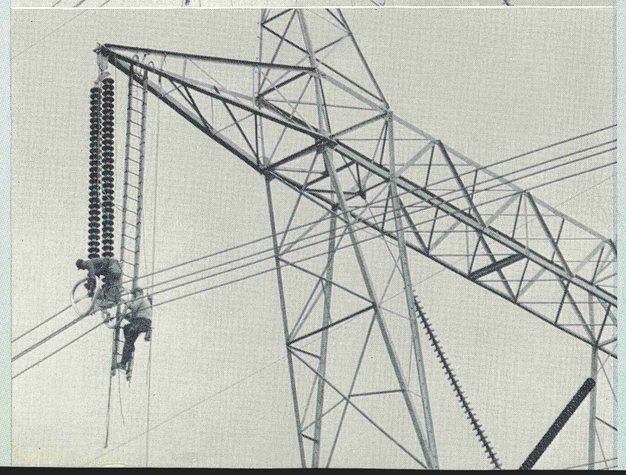
The site lies in the area of Appalachian Power Company and will eventually be occupied, as originally intended, by a steam generating plant for the AEP System.

The test station is energized, as

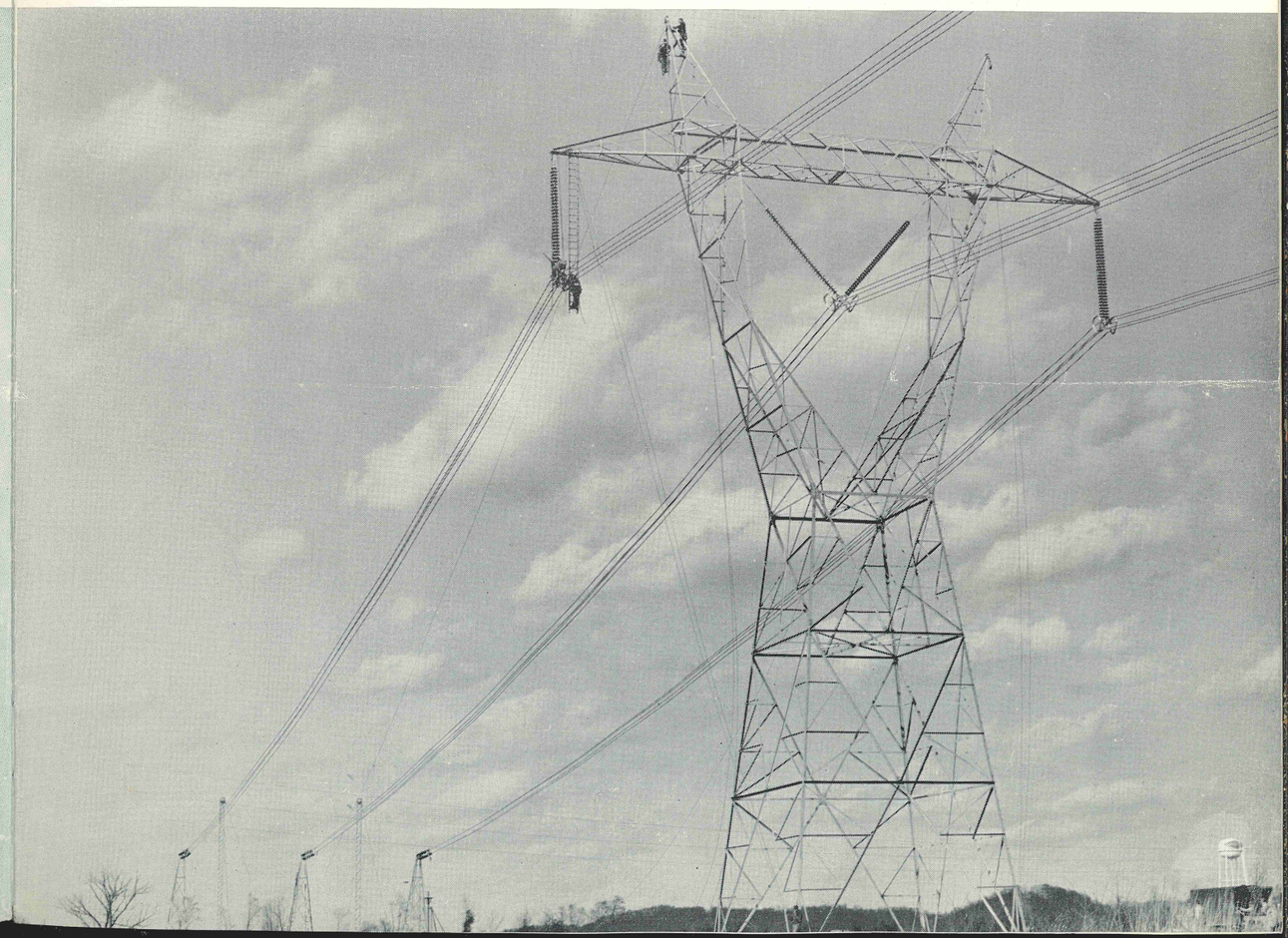


Linemen clip in four-conductor bundle, sag ground wire.

Line crews are dwarfed by 139-foot Apple Grove tower. Outer phase bundles are supported by parallel 34-unit strings of 15,000-lb. suspensions; center phase by 34-unit V-strings of 25,000-lb. units. Line is deadended on pyramidal structures shown in background.



Attaching control shields to suspension assembly.



shown in Sketch A, from a connection with a 138-kv line which crosses the Ohio River at Apple Grove.

The 138-kv is connected through appropriate substation equipment to the low side of a three-phase 138/750-kv transformer. The transformer has four lower taps at 687-kv, 625-kv, 565-kv, and 500-kv. A special 420-volt A.C. tap on the high voltage side permits a special circulating current heating arrangement for the conductors under test.

Since the test station will undoubtedly be fully covered in other publications, we'll confine this report to the transmission lines -- the focal point of the project, and the area in which Ohio Brass was privileged to make a significant contribution.

As mentioned, the west (Ohio River) side of the station is occupied by the transformer and the incoming 138-kv line. From the other three sides of the station, conductors take off at an elevation of 65 feet into the three test lines.

All three lines employ four-conductor bundles for each phase, with phases supported in a flat horizontal configuration.

On the "A" line, all conductors are 1,272 MCM ACSR "Pheasant." On the "B" line, all conductors are 954 MCM ACSR "Cardinal." On the "C" line, the outer phase bundles are "Cardinal," the center phase bundle, "Pheasant."

Conductors are bundled on 18-inch centers. Phase spacing is 45 feet.

Each of the three test lines measures 2400 feet from station to deadend, and each includes a single 1300-foot span in its central portion.

The two towers in each of the test legs are 139 feet high -- 116 feet to the crossarm, another 23 feet to the tips of the two vertical members supporting the 159 MCM ACSR ground wires. Dimensions of the towers are shown in Sketch B.

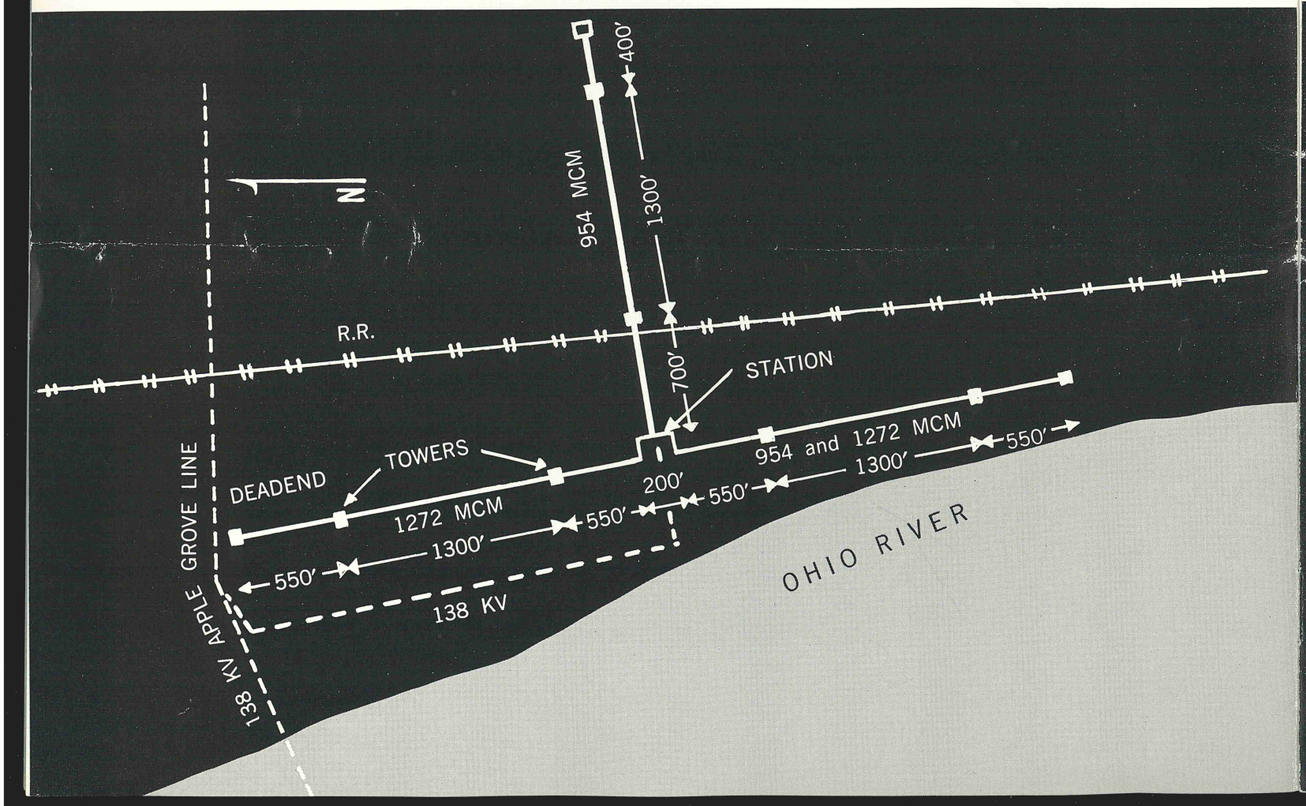
Complete suspension and deadend assemblies -- including insulators, hardware, and control shields -- were designed and supplied by O-B for two of the three test lines, as well as the 138-kv supply line. Throughout test lines and station, O-B spacers are used exclusively.

All suspension insulators supplied by Ohio Brass are of the new Futura design.

The center phase conductor bundle is supported by a V-string suspension assembly (Sketch C). Each leg of the V-string is made up of 34 25,000-pound, 5¾-inch by 10-inch, ball-and-socket type units. Extension links are employed at the tower end of the strings to maintain conductor elevation equal to the outside phases.

Outside phases are supported by parallel strings of 34 15,000-pound units. (Sketch D).

SKETCH A—Plan view of the Apple Grove 750-kv test project.



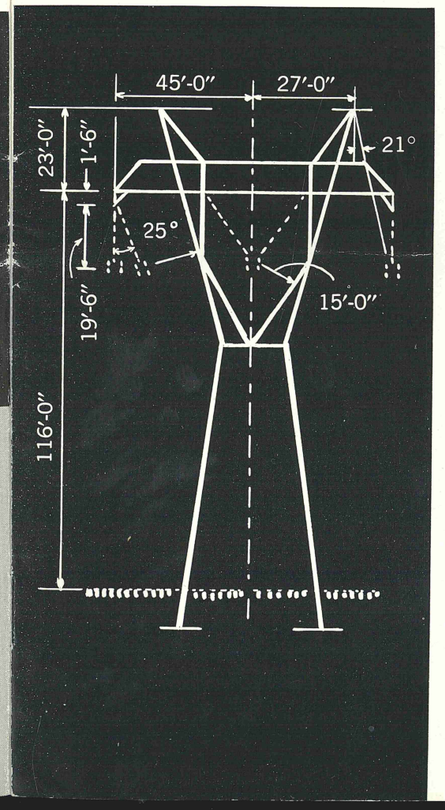
Quadruple strings of 34 25,000-pound units are employed on deadends. (Sketch E). As shown in sketch and pictures, the bundles were rotated 26½° from the vertical at deadends so leads could be dropped vertically from all four conductors without interference.

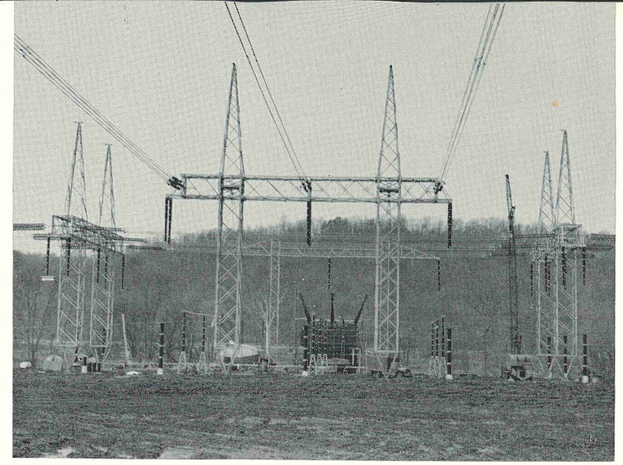
Bundle spacers, as shown in the accompanying pictures, are flexible loops of stainless steel wire with four conductor clamps located at 90° intervals. Distance between spacers in the span is 250 feet. At deadends and in the station they are used as close as necessary to maintain the proper configuration of the bundle.

The design of spacers, suspension and deadend assemblies has been slightly modified to accommodate a distinctive feature of the Apple Grove test line -- the circulation of load magnitude current through all conductors.

The 200-ampere current, supplied by a 420-volt tap on the 750-kv

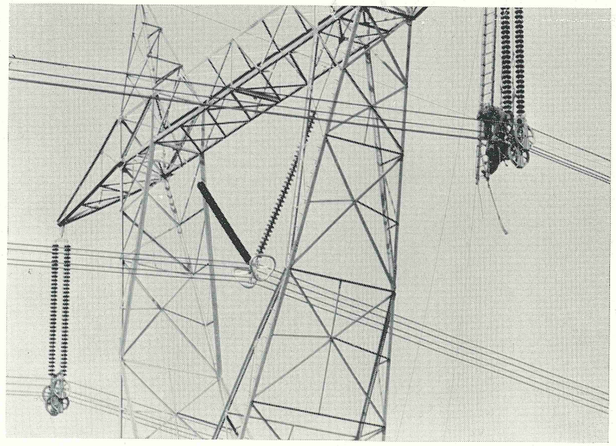
SKETCH B—Dimensioned sketch of tower.





View of the test station during construction -- looking west. Ohio River is beyond transformer. Test lines "A" and "C" run north (right) and south (left), while line "B" runs toward the viewer.

Bundle spacers are attached at 250-foot intervals. Spacer consists of loop of stainless steel wire with conductor clamps positioned at 90° intervals to maintain 18-inch square configuration.



This view shows arrangement of sheave blocks for pulling conductors. Center phase V-string has already been clipped in.

transformer at the station entrance, keeps conductors at a temperature somewhat higher than ambient to hasten drying after rain and to prevent the accumulation of early morning dew -- a factor of undetermined importance in earlier test lines.

The small amount of inter-conductor insulation required has been provided for, in the O-B design, by means of rubber bushings in suspension and spacer clamps and by specially insulated deadend yoke plates. Jumpers between the insulated conductors are used as necessary to complete the heating current circuit.

Aside from these slight modifications, all assemblies have been designed to simulate those which would normally be supplied for a commercial type of operation at 750-kv.

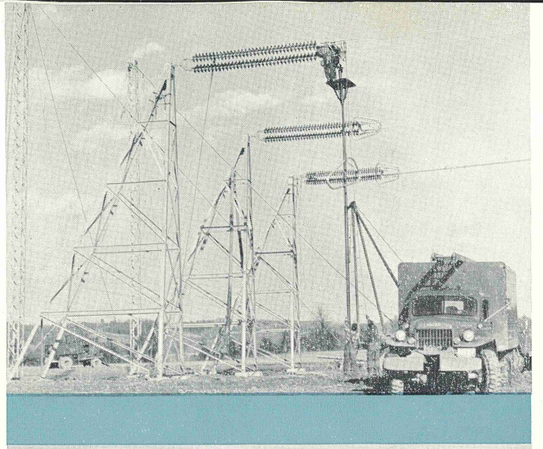
In the course of the three-to-five-year test program, the different conductor arrangements on the three test lines will be evaluated for radio influence voltage and corona loss performance under identical atmospheric conditions.

In earlier test projects, there was a considerable time interval -- and therefore a change in test conditions -- between tests on one conductor arrangement and another. Now, simultaneous measurements can be made under all atmospheric conditions.

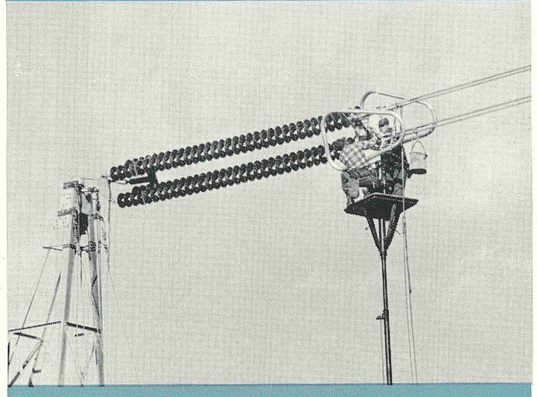
RIV will be measured by means of capacitor connected circuits at each end of each test line. Field strength measurements will be made directly under the test lines and at several distances at right angles from the lines. Watts input, or corona loss, will also be measured.

These quantities, along with significant atmospheric data, will be continuously monitored by recording arrangements.

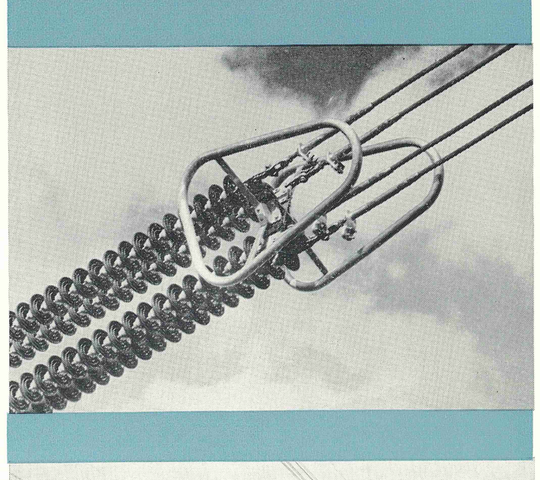
The resulting information -- directly comparing the performance of three different conductor arrangements under identical atmospheric conditions -- will make a substantial contribution to the rapidly developing science of extra high voltage transmission.



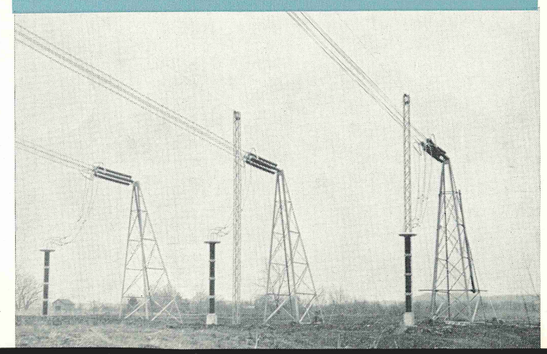
Test lines are deadended 2400 feet from station on pyramidal structures shown here.



Attaching control shields to deadend assembly. Four 34-unit strings of 25,000-lb. insulators are used on the deadend.

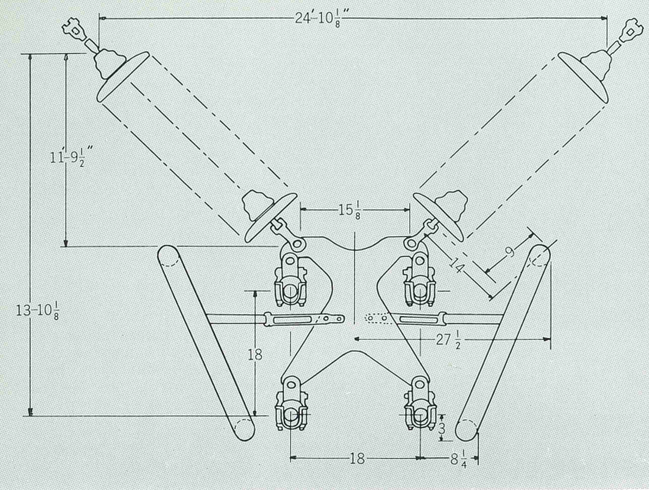


Conductor bundle is rotated 26½° from vertical to permit a vertical drop of leads from the four conductors.

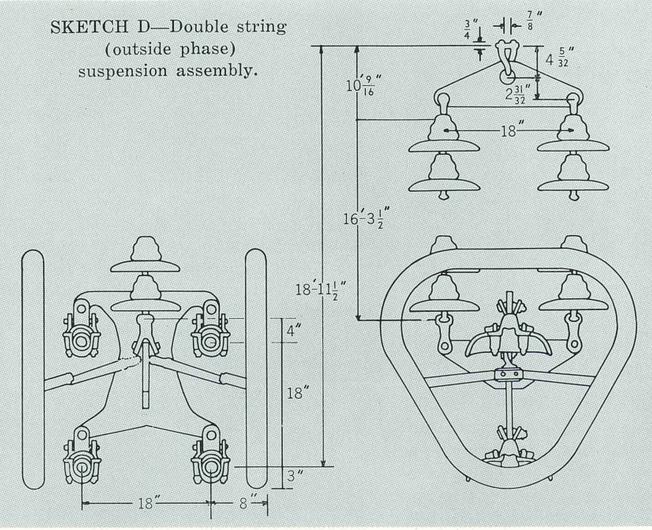


View of completed deadend on south test line.

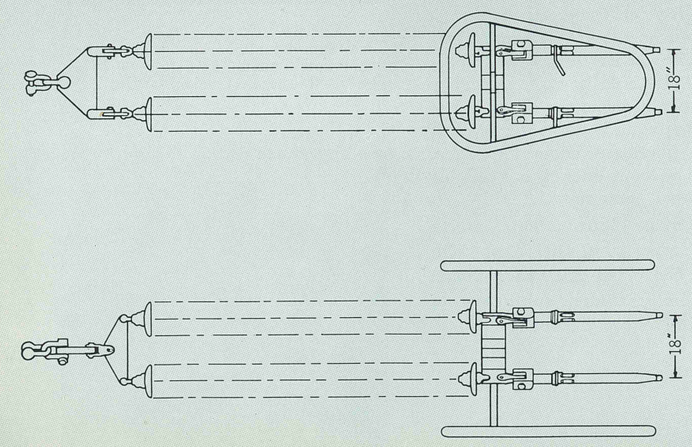
SKETCH C—V-string (center phase) suspension assembly.



SKETCH D—Double string (outside phase) suspension assembly.



SKETCH E—Quadruple string deadend assembly.



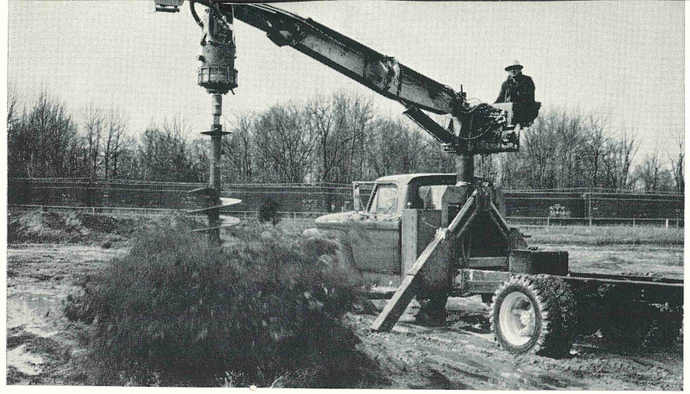
APPLE GROVE USES DAVE LANTZ HARDWARE

Apple Grove is just one of several high-voltage test lines using hardware especially designed for the project by O-B's Dave Lantz.

Dave is our development engineer in charge of transmission and distribution hardware and insulators. He joined O-B in 1948, shortly after graduating from Purdue University with a BS in Electrical Engineering. At Purdue, Dave was elected to the honorary engineering societies of Tau Beta Pi and Eta Kappa Nu. His entire career at O-B has been spent in research and development, first as a laboratory engineer and later specializing in the development of high-voltage insulators and hardware.

Designing hardware for "big" projects is nothing new to Dave. Much publicized high-voltage lines presently using Lantz-designed hardware include: Leadville, Bonneville, "Kitimat," Quebec Hydro, and British Columbia Electric. The B. C. Electric project was the first bundle line in the western hemisphere. Dave designed all supporting hardware including bundle spacers.

In addition to being a Registered Professional Engineer (Ohio) and a member of the American Standards Association, Dave is a member of AIEE and a prolific author of papers dealing with high-voltage hardware and insulators.



Holan's new center-mounted derrick, equipped with the three-speed 5400 Earth Borer, spins a load of dirt to demonstrate its muscle. The digger moves in and out with the seven-foot boom. This, coupled with rotation of 360 degrees, results in a wide radius of action for both the derrick and the digger.

HOLAN DEVELOPS FIRST CENTER-MOUNTED DERRICK WITH ROTATING CROW'S NEST

seven-foot extendible boom provides wide radius of action on all sides of truck

For the first time, utility linemen can operate a center-mounted derrick from a rotating crow's nest -- thus giving them an unobstructed "bird's-eye" view of the work area.

Holan's new 7700 Hydraulic Derrick can be easily mounted on the truck chassis at any point behind the cab and it requires only 18 to 26-inch mounting space, depending upon the mounting and jack choice.

The powerful derrick -- including the base, superstructure and hydraulic outriggers -- is built as an integral unit for ease of mounting and to minimize body and derrick stresses.

The 7700 can handle Holan's three-speed 5400 Earth Borer, lowering to within 30 inches of the ground -- enough to "bury the head" of the most powerful derrick suspended digger in the field.

Not only that, but it can hoist and "live boom" 9,000 pounds and rotate 360 degrees in either direction. Foot pedal controls rotate the derrick and operate the digger. Hand controls are used for raising and lowering the derrick and for extending and retracting the rugged seven-foot boom.

One of the unique features of the new Holan unit is the offset sheave head design which holds the pole away from the derrick leg, thus providing additional clearance for pole-handling.

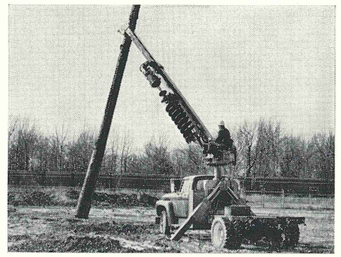
With a sheave height of 32 feet, and operating through a range of 108 degrees, the 7700 can handle 80-foot poles. Diagonal slide-out type hydraulic outriggers provide a 134-inch span for stabilizing the unit. Fold-over type outriggers can be used, providing a 160-inch stabilizing span.

As optional equipment, Holan offers the same semi-automatic locking device for the earth borer as that used on the 7500 Corner Derrick. The device locks the digger to the extendible boom for digging, automatically locks the borer to the end of the main boom when retracted. A fiberglass boom extension, with or without bucket, is available as optional equipment.

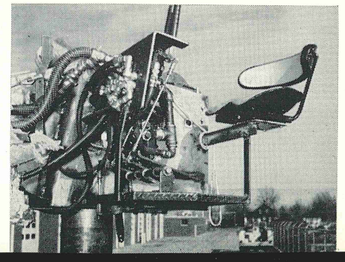
For more information, write Holan Corporation, 4100 West 150th Street, Cleveland 35, Ohio. Holan is a wholly owned subsidiary of The Ohio Brass Company.

The head of the digger is practically buried as the 7700 digs a hole in front of the truck. With the 7700, holes can be dug and poles set on all sides of the unit without moving the truck. Note the slide-out type hydraulic outriggers which provide a 134-inch stabilizing span.

A real demonstration of strength and stability is this action shot showing the 7700 swinging a 2,000-pound pole around the truck -- *butt free of the ground.*

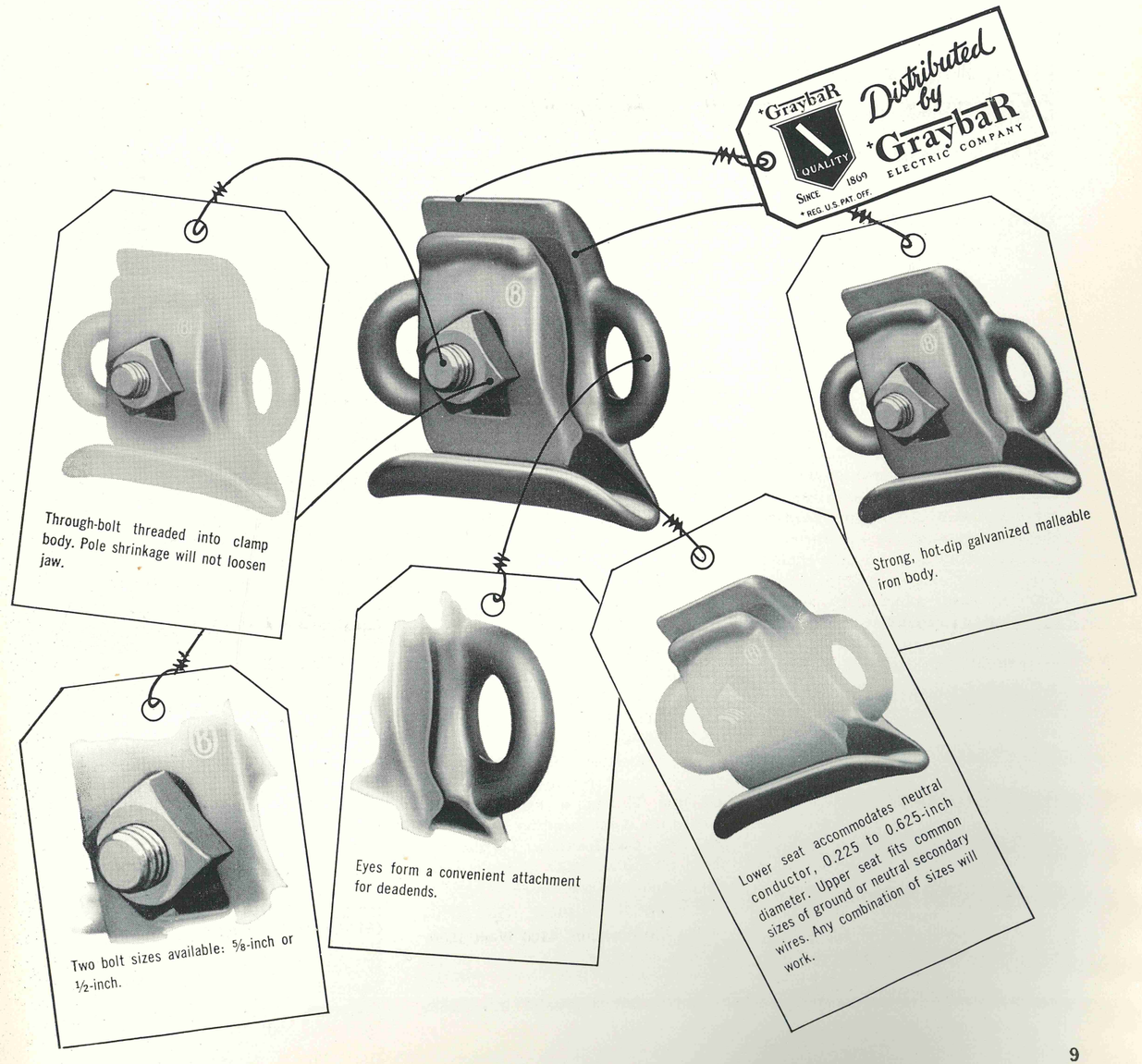


This close-up photo shows the rotating crow's-nest on Holan's 7700 Center-Mounted Derrick -- the first in the field. The foot pedal controls derrick rotation and digger; the hand levers raise and lower the derrick and extend and retract the seven-foot boom.



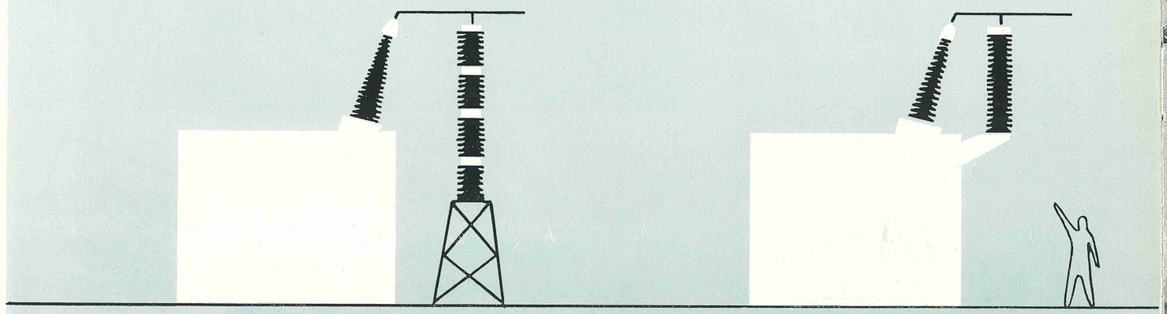
NEUTRAL CLAMPS

. . . act like specialists on a lot of different jobs



If you are still buying and installing high voltage lightning arresters like this:

You can save money in station space and construction costs by installing O-B Thorex arresters like this:



HOW TO SAVE SPACE IN HIGH VOLTAGE STATIONS

All O-B high-voltage, Station Class lightning arresters are small enough to be mounted right on the apparatus or station structure

O-B Thorex Station Class lightning arresters will never be known as the "World's Largest Arresters." At this point in arrester evolution, they are properly called "World's Smallest Arresters."

In fact, the O-B Thorex Station Class arresters have reached minimum height. With present minimum phase-to-ground clearances, arresters can be made no shorter! O-B arrester height is now just as tall as an insulator stack or the exposed end of a bushing of the same voltage rating.

The familiar low-silhouette of the Thorex arrester is particularly evident in the upper voltages such as 138 kv, 230 kv, and 345 kv. These are the voltages that point out the Thorex arrester's unusual advantage over other arresters.

You can save construction costs using these low-silhouette Thorex arresters. With their shorter height and lighter weight, they can be mounted directly on the apparatus in close proximity to the bushing terminal. This is true of even 345-kv lightning arresters. Just eliminate those pedestals and you've saved yourself yard space and construction dollars.

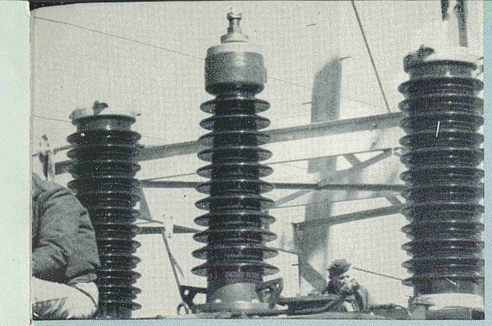
You get closer protection of your major apparatus. No more than a few feet ever need separate the Thorex arrester from the transformer terminal it protects and, by placing the arrester on the transformer, common ground is automatically established with the transformer tank. Both are highly desirable protective measures.

Because of the minimum height of the Thorex arresters, proper clearance is much easier to provide on the transformer. Locate the base of the arrester at tank cover level and the top reaches only to the top of the bushing. This eliminates the need for long, elaborately braced brackets on the side of the transformer.

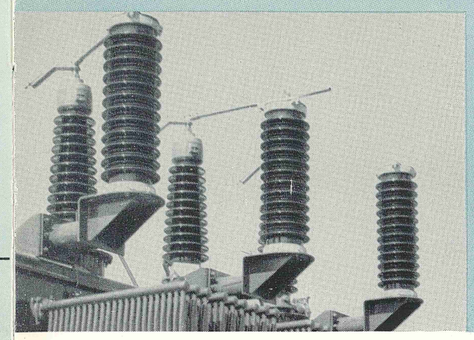
These low-silhouette arresters are just the thing for station entrance arresters. There's no need to build special pedestals here, either. Install these arresters like insulator stacks right in the station entrance structure. Suspend them by the cap or base mount them.

In fact, the comparison to an insulator stack is quite favorable. Here's a tabulation:

	MPR-276 arrester	Pincaps 1300-kv BIL
345 kv (1300-kv BIL)		
Height	109½″	105″
Weight	1050#	800#
Porcelain Diameter	16¾″	18″
	MPR-195 arrester	**Pincaps 900-kv BIL**
230 kv (900-kv BIL)		
Height	80″	76″
Weight	817#	440#
Porcelain Diameter	16¾″	17″
	MPR-121 arrester	**Pincaps 550-kv BIL**
138 kv (650-kv BIL)		
Height	53″	47″
Weight	496#	270#
Porcelain Diameter	16¾″	17″



High voltage arresters installed on the transformer provide closer protection of equipment and lower construction costs.



Thorex "low-silhouette" lightning arresters are no taller than the bushings they protect.

Heights do not include terminals. Add approximately six inches to the arrester height for the cap terminal which is normally shipped with the arrester. Final height of the pincap stack would depend upon your choice of terminals or switch construction.

But we are discussing inches and fractions when the difference between the O-B Thorex Station Class arrester and any other Station Class arrester you can buy is measured in *feet!* Let's compare this low-silhouette Thorex with Station Class arresters O-B made up to 1957 because this is the approximate size of other "reduced height" arresters today:

	Low Silhouette	Old
345 kv (MPR-276)	115½″	205½″
230 kv (MPR-195)	86″	151½″
138 kv (MPR-121)	59″	92″

All these figures include terminals. The differences, then, are 7½, 5½, and 2½ *feet*, respectively. Impressive? You bet. And, O-B arresters weigh only half that of the next lightest Station Class arrester. Here's where you can save the cost of O-B Thorex Station Class arresters - by avoiding that extra height and, that extra weight in the design of the station.

Field installation of the low-silhouette O-B Thorex Station Class lightning arresters will surprise you, too. A work crew of two men, plus a light hoist, usually can install even the largest model in a matter of a few minutes. No need to spend time and money bolting units together. All Thorex Station Class arresters are one piece and can be lifted from the crate and into service in just one lift of the hoist.

There's extra value in Thorex Station Class arresters and that means savings for you.

ready to help you at extension 364

JOHN POSEY AND THE FOURTH SUGGESTION

It usually requires several months to manufacture a bushing for horizontal mounting. John Posey, O-B's bushing sales engineer, recently cut the time in half -- as far as one of our customers is concerned.

He did it with a suggestion.

It began when John received an order for a 34.5 kv bushing. It would be mounted horizontally and the customer requested quick delivery. Knowing it would take too long to manufacture a special bushing, John phoned the customer. They discussed the application. John offered four solutions. The customer snapped at the fourth -- adapting a standard bushing with pipe plugs and the customer installing an auxiliary oil reservoir. It would adequately serve the purpose and be delivered well within the required time.

As far as the customer was concerned, John's bushing know-how had saved time and money. For John it was merely giving usual customer service.

A veteran member of the O-B inside sales force, John holds a degree in electrical engineering from Purdue University. Besides bushings, he has worked with capacitors, lightning arresters, transmission and distribution hardware, and all the other products supplied to utilities. He has experience and product knowledge and employs them in giving you the best customer service possible.

Uniform dimensions of O-B Multiresters increase adaptability

All voltage ratings of O-B Multiresters provide the advantages of coordinated dimensional uniformity. Terminal accessories and mounting attachments fit all models, permitting maximum flexibility in application practices.

Bases of all arresters are 3½-inches outside diameter and are drilled and tapped one-half inch deep for standard five-eighth-inch studs. Top terminal of three-to-20-kv arresters accommodates a three-eighth-inch stud, while units rated 27 to 37 kv have a cap that is identical to the base and use a reducing bushing to provide for the three-eighth-inch terminal stud.

Diameter of the clamping portion of all porcelain housings is 3¼ inches in accordance with the requirements of optional hanger-type mounting devices.

Number of skirts on porcelain housing determines leakage distances of individual Multiresters, measurements being made from top terminal or cap casting to clamping band on hanger-mounted arresters and to base casting on base-mounted arresters.

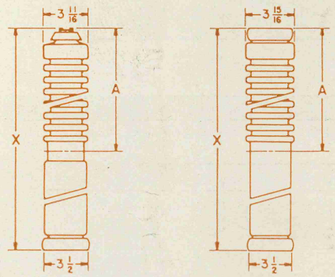
Identification and rating of Multiresters are etched into the porcelain immediately below the space provided for the clamping band.

Type No.	Dimensions: "X" Over-All Height	Dimensions: "A" Height Above Center Line of Bracket	Leakage Distance: From Terminal to Hanger	Leakage Distance: From Terminal to Base
	Inches	Inches	Inches	Inches
DA 3	6 3/16	3 1/16	3¼	6
DA 6	7 9/16	4	4⅞	7¾
DA 9	9 15/16	6 13/16	9½	12
DA 10	10 9/16	6 13/16	9½	12½
DA 12	12¼	8 11/16	12¼	15½
DA 15	14 9/16	10 9/16	15½	18¾
DA 18	16⅞	12 7/16	18½	22½
DA 20	19¼	13⅜	20	25
DA 27	26¾	18⅜	34¼	42⅜
DA 30	26¾	18⅜	34¼	42⅜
DA 37	31⅝	18⅜	34¼	47¼

THOREX® MULTIRESTER

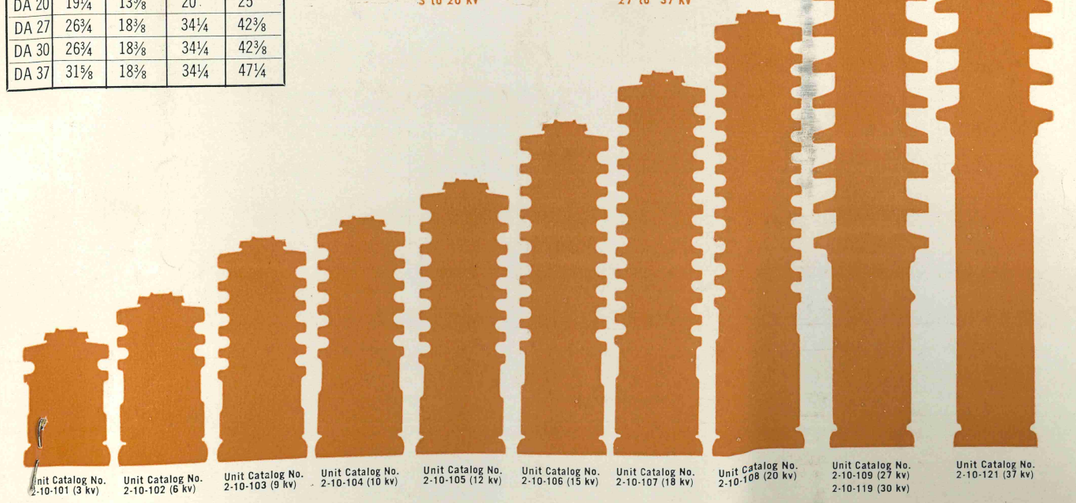
Sturdy base casting has five-eighth-inch tapped hole which provides easy assembly of optional ground-terminal accessories or simple base mounting of three-to-20-kv arresters using a cap screw or extended stud.

Dimension Diagrams



3 to 20 kv

27 to 37 kv



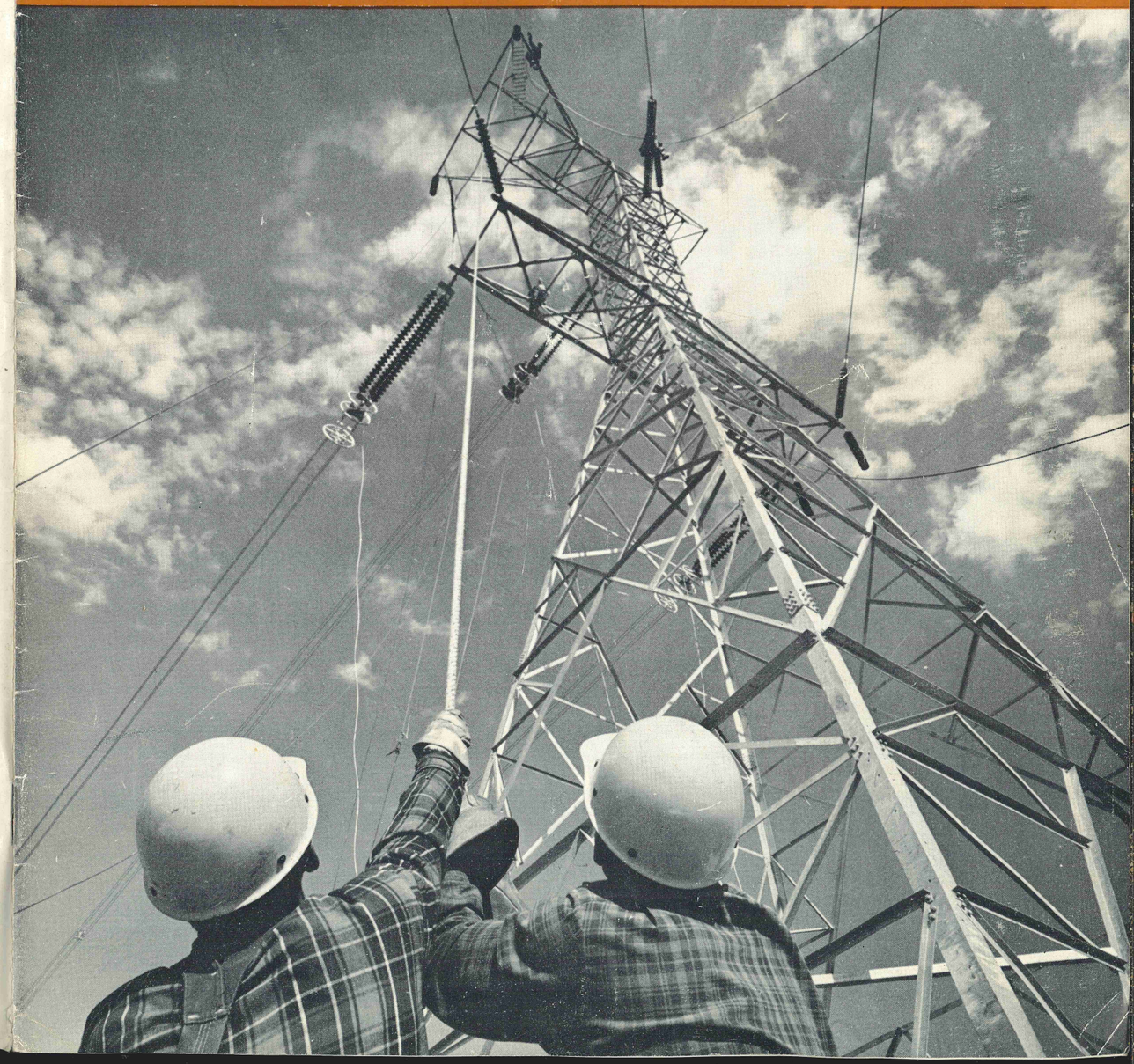
6520-H Printed in U. S. A.

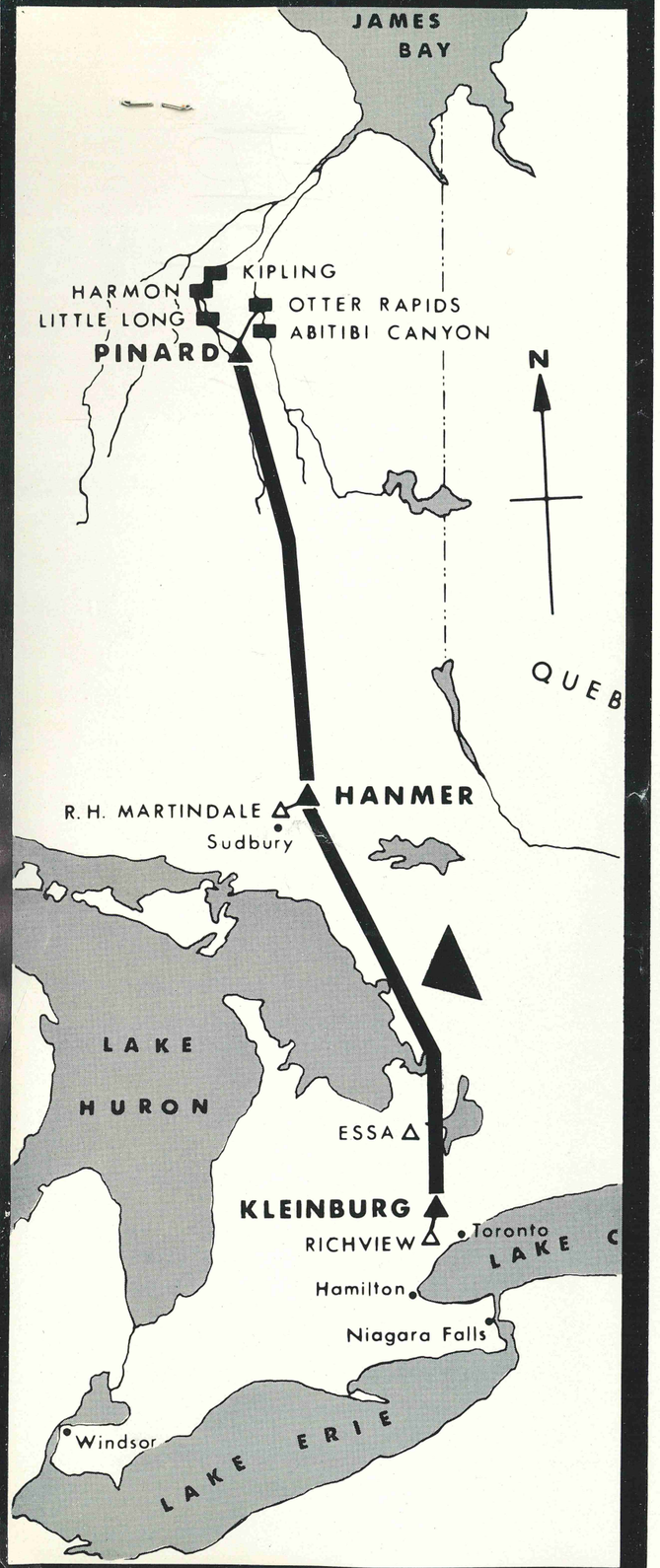
8888

HI-TENSION NEWS

PUBLISHED BY OHIO BRASS COMPANY, MANSFIELD, OHIO - VOL. 34, NO. 2 - FEBRUARY 1965

Connection of this deadend structure marked completion of the first 230-mile leg of Ontario Hydro's 500-kv line. Construction of the second 210-mile section is progressing southward -- see page 2.





EXTRA-HIGH-VOLTAGE TRANSMISSION SYSTEM

MILES
0 50 100

- GENERATING STATIONS
- TRANSMISSION LINES 500 KV
- TRANSMISSION LINES 230 KV
- TRANSFORMER STATIONS 500 KV
- TRANSFORMER STATIONS 230 KV

Path of the new Ontario Hydro 500-kv transmission line from generation sites on the northern rivers to the Toronto area. The arrow marks progress of construction late in 1964.

Ontario Hydro builds 440 miles of 500-kv transmission line

Will deliver over 560,000 kw to Sudbury and Toronto areas from generating sites on Moose River watershed

Each month ten more miles of guyed V-type towers supporting strings of suspension insulators and three phases of four-conductor bundle rise above the plains of southern Ontario, as the new 500,000-volt transmission line of Ontario Hydro progresses southward. One leg of this new system is complete and operating at 230 kv, waiting for construction of the second section before conversion of the 440-mile line to 500 kv operation in 1966. When the line is finished, approximately 560,000 kilowatts of power will be fed into the 230-kv transmission networks at Sudbury and Toronto from four generating stations on the Abitibi and Mattagami rivers. These 230-kv networks cover northeastern and southern Ontario.

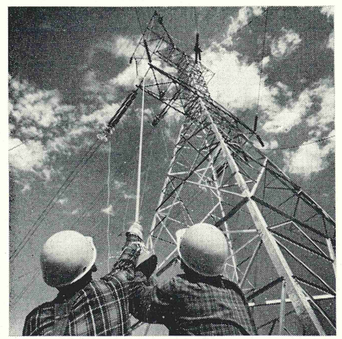
Rapid growth in power demands over the past ten years projected the need for additional generating capacity to the Hydro-Electric Power Commission of Ontario. Existing 115- and 230-kv systems were supplying more than 5,300,000 kw, but future additions to installations on these systems proved uneconomical. For more power, Ontario Hydro engineers looked toward the vast untapped resources of the northern rivers, and found a potential of over 2,000,000 kilowatts obtainable from ten sites in the James Bay area. Nearly 1,500,000 kw of this potential was located on the Moose River and its tributaries.

When the decision was made to develop the resources available on the northern rivers, it became apparent that existing 230-kv systems would be completely inadequate as patterns for construction. Research for the new line began in 1959, with construction of the Coldwater extra-high-voltage (EHV) project. Here transmission voltages, tower designs, insulator-hardware combinations, switching surge performance, impulse performance, and RIV characteristics were thoroughly studied.
(Continued on next page)

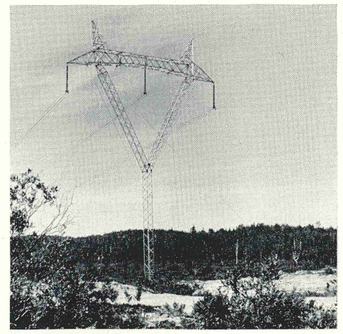
SPECIFICATIONS FOR ONTARIO-HYDRO 500-KV TRANSMISSION GRID

	NORTHERN SECTION PINARD T.S.—HANMER T.S.	SOUTHERN SECTION HANMER T.S.—KLEINBURG T.S.
Average Span	1400 feet	1100 feet
Insulator Strings	23 units single or double on tangent structures 26 units in triple string at strain sites	25 units single or double on tangent structures 28 units in quadruple string at strain positions
Insulator type	5¾″ x 10″ ball-socket 25,000-pound M & E	5¾″ x 10″ ball-socket 25,000-pound M & E
Switching Surge	940 kv Crest	1050 kv Crest
Towers	Guyed V—aluminum & steel	Guyed Y—aluminum Guyed V—steel
Crossarm height	99 feet	90 feet
Groundwire height	121 feet 6 inches	112 feet 6 inches
Shielding angle	20 degrees	20 degrees
Phase spacing	40 feet	41 feet 6 inches
Footing resistance	15 ohms or less	25 ohms or less
Guys	11/16″ galvanized steel	9/16″ to 3/4″ galvanized steel
Guy angle	57 degrees	57 degrees
Conductor	Four per phase	Four per phase
Size	.90-inch ACSR	.85-inch ACSR
Spacing	18 inches square	18 inches square

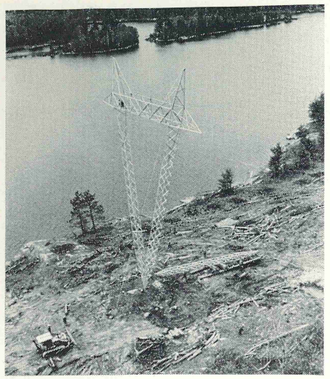
The first 100 miles south of Pinard Transformer Station crossed flat terrain covered with muskeg. Here, one of the special "muskeg buggies" crosses a section of heavily forested muskeg terrain.



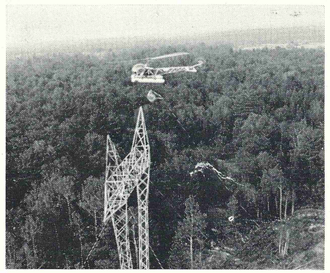
Construction is completed on the first section of the Ontario Hydro line with connection of this deadend structure to the Hanmer Transformer Station near Sudbury.



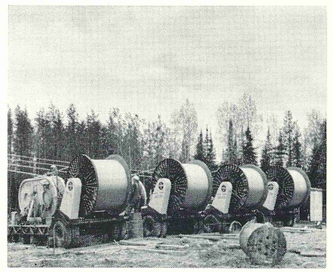
First use of a new guyed Y-type aluminum tower is noted on Ontario Hydro's 500-kv line.



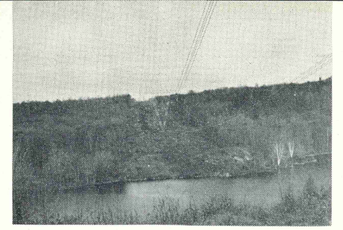
Tangent and light angle positions on the northern sections use guyed V-type towers, while the southern section utilizes guyed V-type and Y-type structures. The guying angle is approximately 57 degrees, and each anchor is pulled to 35,000 pounds before the guy is attached.



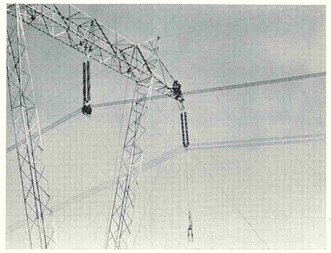
A preliminary pulling line of polypropylene rope is strung by light helicopter, and is used to pull through the "bull-line" for stringing. Helicopters were also used for transporting men and materials into impassable areas.



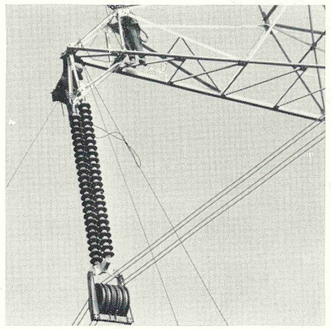
All four conductors in each phase are strung and tensioned simultaneously with these rigs. Pulling is done by a winch located at the opposite end of the section, and the 2200 pound tension is hydraulically controlled.



Looking north, this is the right-of-way as Ontario Hydro's new 500-kv line crosses Blackstone Lake near Parry Sound. Notice the painted tower sections for aircraft visibility.

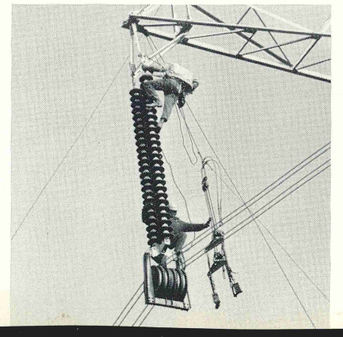


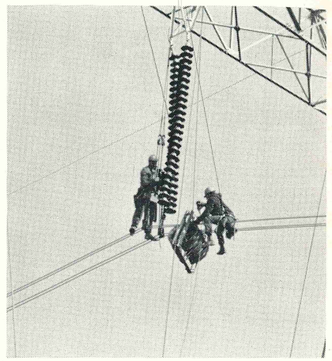
Clipping-in of the four-conductor bundle is in process at a heavy duty position on the south bank of Blackstone Lake crossing. One phase is complete and workmen prepare to transfer to the middle phase.



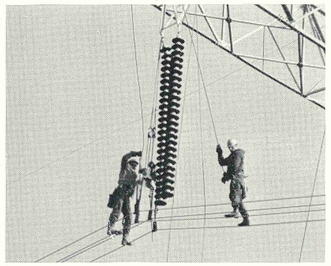
A lineman climbs down the insulator strings and stands on the four conductor bundle while removing the stringing blocks and installing the yoke assembly.

The lineman on the insulator strings raises the three-ton chain hoist as the man on the stringing block guides it into position. All insulators in the string are 25,000-pound M & E rated units with ball-socket connection.

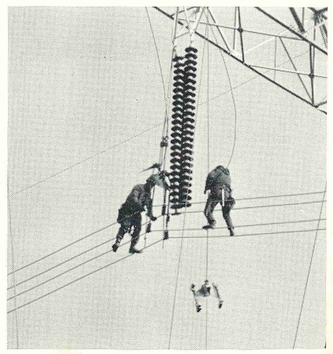




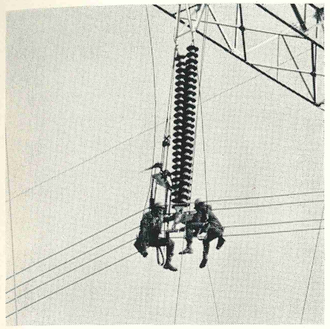
With the chain hoist attached, the stringing block is removed and prepared for lowering to ground crews. Notice the lineman holding the insulator strings apart to prevent contact.



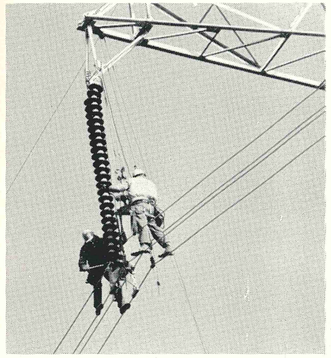
The two inside conductors are raised above the outside members to assume the approximate 18-inch conductor spacing of the final configuration. Linemen stand on the conductors, and have a "scare" rope attached to them and the tower for safety and to give them freedom of movement.



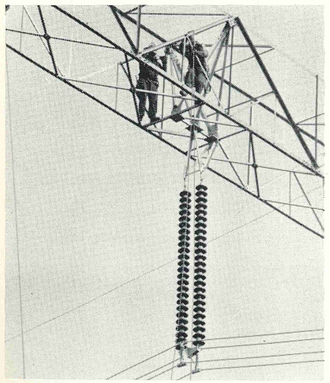
With the .85-inch ACSR conductors in the approximate position, the yoke assembly is raised for attachment.



Workmen position the clamps onto premarked positions and snug the clamps up to grip the conductor.



One lineman torques the clamp pressure to 500 inch-pounds as the second hoists the bundle up for attachment to insulator strings.



Installation of the yoke assembly is complete, and the linemen prepare to transfer this handline to the next phase.

(Continued from previous page)

From these exhaustive tests came the detailed specifications for the first 500-kv system in Canada.

Four generating sites were selected -- Harmon, Kipling, Little Long, and Otter Rapids on the included map. These four stations will send power at 230 kv to the Pinard Transformer Station. Voltage will be stepped up to 500 kv, and the 440-mile journey south to Toronto will begin.

Construction of the transmission line was divided into two segments, with two sets of specifications as shown in the specification table on page three. The first leg extends 230 miles from the Pinard T. S. to Hanmer T. S., and has been operating at 230 kv with existing 115- and 230-kv systems since 1963. The first 100 miles south from Pinard T. S. crossed flat country covered with muskeg (water-saturated decayed vegetation or "peat" supporting living vegetable cover). Swamp and gravel compose the next 70 miles, with the remaining 58 miles made up of rocky terrain interspersed with swamps. The entire length of this first section is heavily forested, and necessitated clearing more than 5000 acres of dense brush.

Structures on the northern leg are guyed V-type towers of either steel or aluminum. Towers are designed to withstand wind gusting to 80 mph without ice, or winds of 35 mph with ½-inch radial ice load. With no wind, the structures will support a ¾-inch ice load. In the event any one of the four anchors should fail, the tower will continue to support the ¾-inch ice load or a 60 mph gusting wind.

From the Hanmer Transformer Station, the second leg of Ontario Hydro's 500-kv line stretches to Essa Transformer Station, near Barrie. At this writing in late 1964, construction has progressed to approximately the location indicated on the included map.

A typical construction operation begins with stringing the conductor after footings and anchors have been installed and towers erected. First crews raise insulators and stringing blocks, three per tower, for a 28,000 foot length of line (about five miles or 20 towers). Next, stringing equipment is set up with a six ton reel of conductor mounted behind each unit and feeding through each of four tensioners. Five miles away the tandem puller is positioned to pull in the "bull-line," or pulling line to which the four conductors for each phase will be attached.

While the equipment is being positioned, a helicopter is used to string out a light polypropylene rope on the ground for each phase. This rope is laid out in 7500 foot lengths, joined, lifted into the stringing blocks, and attached to the pulling machine. It serves to pull in the ¾-inch wire rope "bull-line." Stringing this preliminary line by helicopter takes approximately 2½ hours, and saves many hours for men and equipment on the complete pulling operation.

All four conductors from separate reels are fed through the tensioners, then attached by a specially designed "running board" to the one pulling line. All four .85-inch ACSR conductors for each phase are then pulled through at once. Conductors are pulled for 28,000 feet, with about 2200 pounds tension maintained to prevent the conductors from touching the ground between towers. Finally the conductors are properly sagged and clamped to the insulation system, and a motorized cart travels on the conductors to allow linemen to install spacer-dampeners every 400 feet, check splices, and make a final inspection of conductor surface.

Unique features of the new Ontario Hydro system include the use of the first guyed Y-type aluminum towers, use of only 25,000-pound M & E rated suspension insulators in all positions with single, double, triple, and quadruple string combinations, and limited use of computer placement of towers to effect maximum advantage of terrain and tower position. Further detailed information may be derived from the following photographs taken on the completed section and at construction sites near Blackstone Lake between Parry Sound and Barrie, Ontario, Canada.

Holan develops new high-strength fiberglass boom; testing credited with success of developmental program

It could be said that the Holan Division of The Ohio Brass Company is in the lifting business -- either men or material, often both.

Product integrity cannot be compromised. All Holan aerial devices or derricks - components, complete units, and accessory items - must meet rigid field application requirements. Each one is subjected to exhaustive and testing procedures.

Proof-testing -- nondestructive by nature -- is conducted by Holan and The Ohio Brass Company. Such tests are quality-control techniques and provide assurances that the most severe field requirements be met.

But basic research and development, as well as quality-control programming, calls for a type of testing that demands engineers to convert and modify theory into products of predictable performance. Destructive testing, more often than not, establishes and confirms the data needed to obtain these results.

Test engineers in Holan's prototype shop work to find important answers. Their findings not only prove product integrity but often reveal new techniques that are used to improve existing products.

Here is an example: Holan's exclusive, manual, mechanical-pullout boom for Mustang derricks is available in fiberglass, and it accommodates load and personnel-carrying accessories. This unique extension nests within the hydraulic-extendible boom of the derrick. It presents an unusual problem.

Failures in fiberglass occur where the material is stressed in compression - in the *underside* of the boom. The problem was to develop a fiberglass boom capable of handling the same loads - with the same factor of safety - as the derrick itself.

Cross-section size and configuration of this manual pullout are limited because it telescopes within the hydraulic-extendible boom. Telescoping eliminates the possibility of strengthening the pullout by merely adding material or changing the configuration. The only way to improve the mechanical properties was through better physical characteristics and imaginative design.

Holan engineers launched a testing and evaluation program to prove the newly obtained mechanical properties and design theories.

Many booms were broken on a specially designed testing machine that duplicated the most critical loading and stress conditions. Both steady and cyclic loads were applied to prototype booms at derrick angles and tested to destruction.

Based on data obtained through the testing program, Holan's technical staff modified fiberglass manufacturing techniques to obtain optimum physical and mechanical properties of the material. After exhausting all possible fiberglass combinations, it was determined that a steel insert could be used in combination with fiberglass, yet still maintain the original dielectric requirements. Again, testing procedures were employed to establish exact lengths and configuration for the steel inserts used in construction of the boom.

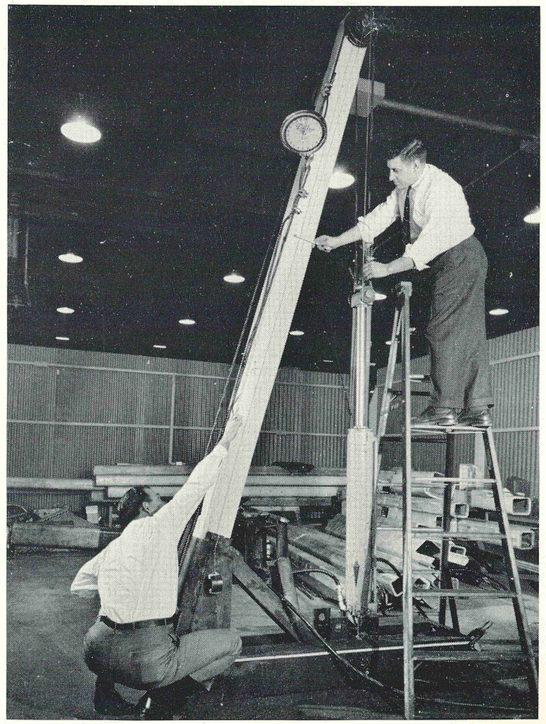
In short, a uniformly stressed fiberglass boom for a specific application was developed by this intensive research and testing program. Furthermore, the design innovations and the improvements in manufacturing processes, which resulted from this particular program, are being incorporated in other Holan products.

For information about Holan equipment, write Holan -- Division of the Ohio Brass Company, 4100 West 150th Street, Cleveland, Ohio 44135.

1. Holan test engineers measure deflection of a prototype fiberglass boom. By measuring at points along the boom, they are able to correlate test values and theoretical calculations to determine total deflection. The objective is to arrive at an efficient and uniformly stressed beam design as indicated by a uniform deflection.

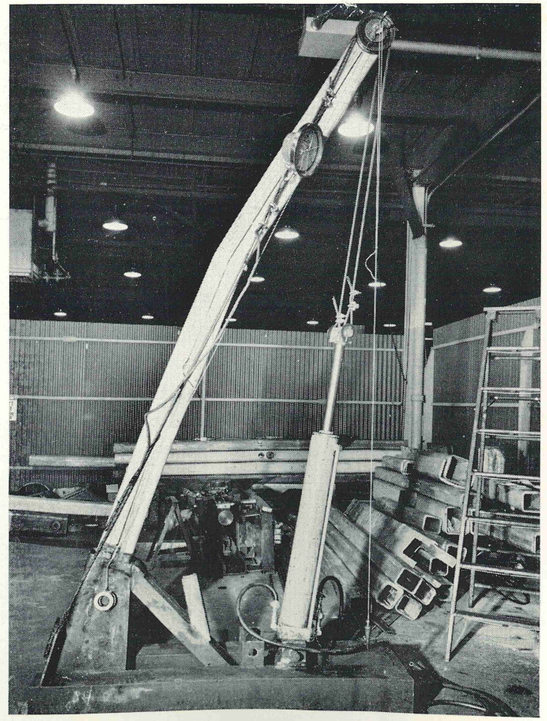
2. Double-exposure graphically illustrates the uniformity of deflection of Holan's fiberglass boom. Tests determined that a 75-degree angle was the most critical stress position. Booms withstood cyclic loading to within 10 per cent of loads required to cause failure under static-loading conditions.

3. Sufficient load was applied to fracture boom. Holan's testing equipment simulated actual derrick cable hookup -- cable over the boom, through sheave, attached to load -- which increases compressive loading. Note booms on floor which were tested to fracture during the program. This is indicative of the magnitude and cost of carrying on an extensive testing and evaluation work.



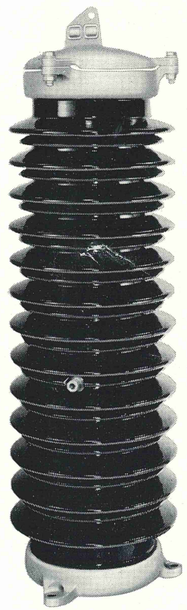
1.

2.



3.

O-B tapped arresters save valuable construction time on TP&L substation voltage conversion



Alternate arrester ratings are obtained on O-B's MPR models by factory installation of a bronze tap which penetrates the one piece porcelain arrester housing.

Load growth on Texas Power & Light Company's Carrollton 69-kv substation overloaded present transformer equipment. Although the Company's new 138-kv transmission line is scheduled for completion in 1965, a substantial increase in capacity was required immediately. This led to the decision to completely rebuild the substation more than a year before the line conversion to 138-kv operation.

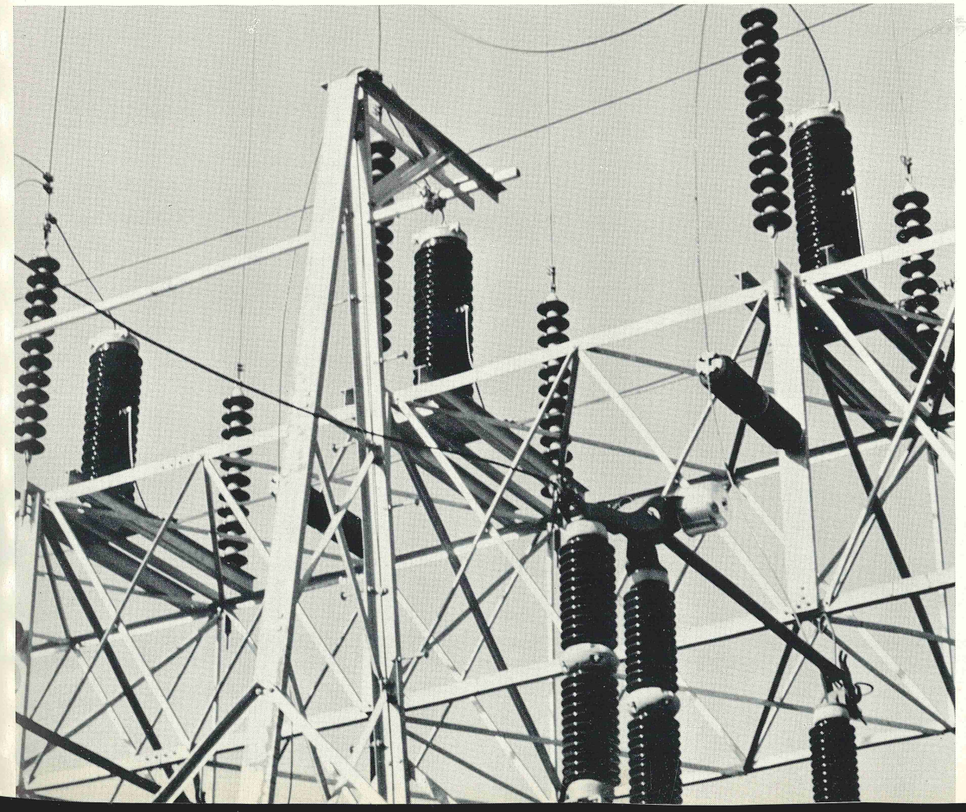
To provide increased capacity, two 7500-kva transformers were replaced with two 15000/28000-kva units having a series-multiple high side winding rated 69 x 138 kv. Reconstruction of the station provided the opportunity to install 138-kv switches and buswork and all other equipment associated with converting the station to 138-kv operation in 1965. It was desirable to arrange all new equipment such that the absolute minimum amount of labor and time would be required to change station operating voltage. Particularly significant in this precise planning was the installation of Ohio Brass Tapped MPR Dynagap arresters rated at 60/120 kv.

Tapped arresters were selected because this type arrester will function at both the present and future voltages. When originally installed for 69-kv operation, a jumper cable connection was provided from the terminal tap of the arrester to ground. This temporary connection provides 60-kv arrester operating characteristics with full station-class protection for the 69-kv installation. When the time of voltage changeover comes, the ground cable to the tap will simply be removed and connected to the base terminal. The arrester will then function as a 120-kv unit, providing protection for the 138-kv equipment.

While this installation of tapped arresters obviously saves considerable expense of obtaining and installing new arresters at the time of the voltage conversion, the more important consideration at the Carrollton substation is the saving of time. It is estimated by Texas Power & Light Company engineers that removal of 60-kv arresters and installation of 120-kv arresters would require three men approximately two hours, as compared to 15 minutes to remove the temporary grounding connection on the tapped arrester.

The O-B MPR Dynagap arresters fit into Texas Power & Light Company's integrated plan for converting the substation with minimum expenditure of labor and money.

Carrollton Substation of Texas Power & Light is scheduled for 1965 voltage conversion from 69 to 138 kv.



Jumper connection to terminal tap on arrester provides protection for system operation at 69 kv.

LLBM solves cross-bus problems

Electric utility uses insulated Holan elbow for fast, safe handling of difficult midspan work in 69-kv substation

Flexibility of working the Live Line Barehand Method with a Holan elbow is clearly demonstrated in the installation of this cross bus.

The live line crewmen used the LLBM while installing the permanent jumpers. Hot sticks were used for installation of the temporary jumper while the linemen were free from the energized conductors.

Installation of this cross bus with a Holan elbow eliminated the need for the erection of a utility pole under the bus work and the need for linemen to work the energized lines from the pole.

Background on this job: the utility built a 69-kv line, a substation, and a nearby breaker station. The 69-kv ran north from the sub.

Also emerging from the substation was a 12.5-kv line which served areas in the opposite direction. This line was insulated for 69 kv when it was constructed. The decision was made to boost the power from 12.5 kv to 69 kv.

In order to raise the voltage, a cross bus was planned and jumpers were needed to tie the existing energized 69-kv line with a newly constructed breaker station and the former 12.5-kv line.

Three guyed poles, one for each phase, were set in a row parallel to the bus. A single phase from each pole was strung to a single, vertical-corner pole across the yard. These new, de-energized lines were strung approximately four feet under the energized 69-kv lines and deadended on a single, double-guyed corner pole. From here the three phases entered the breaker station and connected with the 69-kv line which served south of the station.

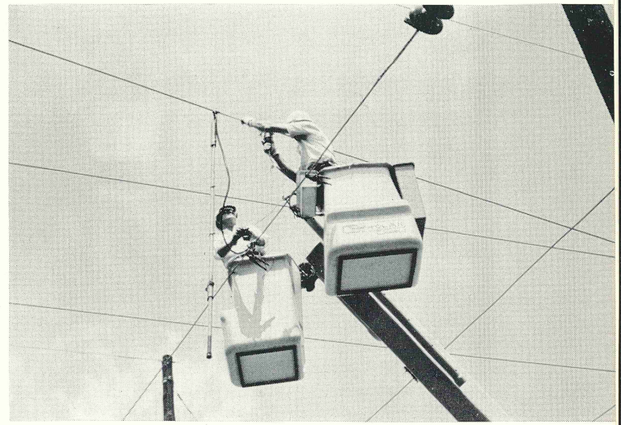
Procedure for making live line jumper connections incorporated a combination of LLBM and hot sticking with a Holan insulated elbow. First step was to connect one end of the temporary jumper to the newly constructed, de-energized line below. Next step was to use a hot stick to make a connection on the energized phase overhead with the other end of the jumper.

The hot stick was used in this work procedure as an extra safety precaution. Initial contact between an energized 69-kv line, and a line built for 69 kv but unproved at that voltage, was considered hazardous.

Installation of the permanent jumper was done with the Live Line Barehand Method. A T-shaped compression clamp was attached to the conductor overhead and the permanent jumper was connected to the shaft of the clamp. The procedure was reversed in fastening the jumper to the lower conductor. At this point, the permanent jumper was completed and the temporary jumper was removed. This cross-bus work was done for all three phases of 69 kv as described.

Summary: During installation of the temporary jumper the bucketmen used a hot stick, but installation of the permanent jumper was done with the Live Line Barehand Method. At all times the work was within convenient reach of the men in the buckets. They could move their Holan elbow with caution, yet with complete safety. The job took fewer manhours and less effort than any method previously used. The men were not fatigued and were fresh for additional work. Therefore, the cross-bus job cost less than if it had been done with conventional methods.

Three phases of a 69-kv cross bus being connected with permanent jumpers. Holan elbow safely puts crewmen within arm's reach of the job, relieves undue tension and eases problem of fatigue.



Temporary jumper has been installed with a hot stick and live line crewmen prepare conductor for permanent jumper. Bucket men are bonded to conductor and are using the LLBM.

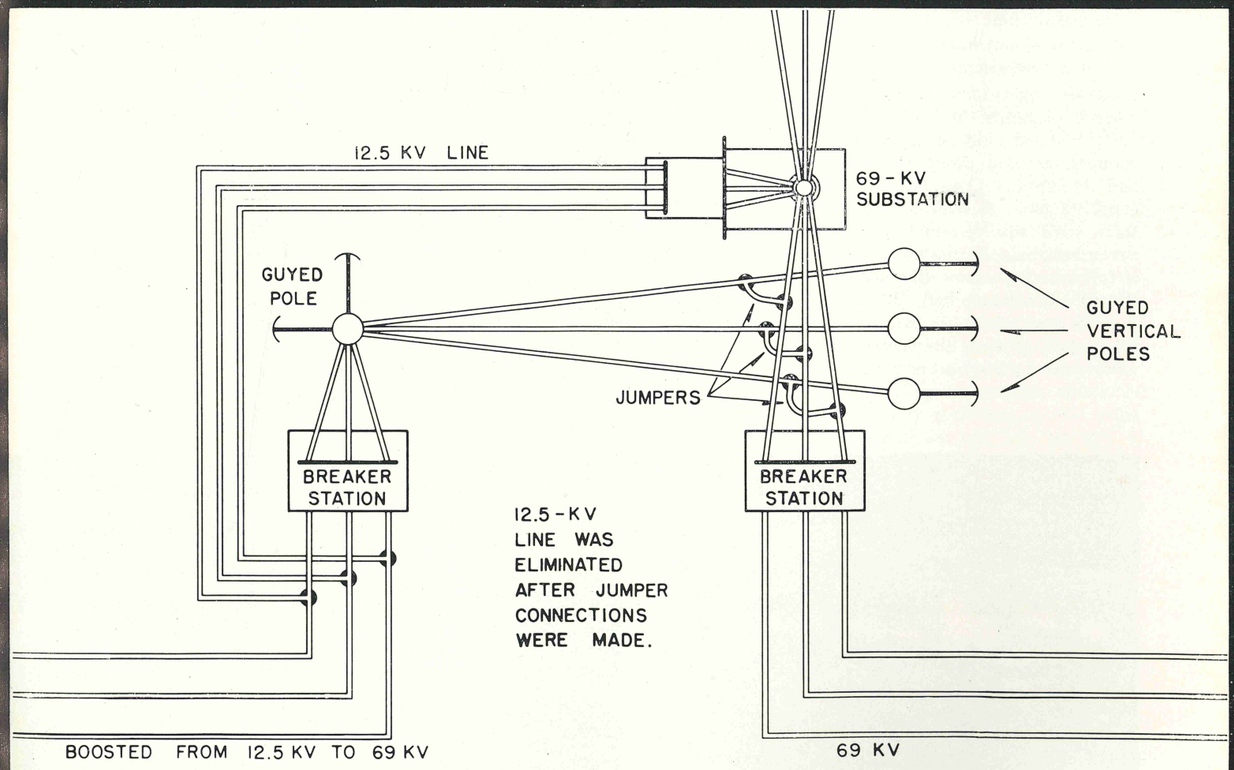


Diagram of cross-bus job in 69-kv substation. Three phases from guyed poles (at right) crossed below the energized 69-kv lines between substation and breaker station. Jumpers were installed with a Holan elbow; linemen used the LLBM and hot sticks.

Stringent testing of Varex® capacitors establishes progressive productive control

Balanced operating characteristics of Mark IV Varex capacitors are obtained by combining only the finest quality materials with precisely regulated assembly procedures. Closely paralleled with the laboratory acceptance tests on materials *(Hi-Tension News Jan. '65)*, a series of equally exacting production tests maintains tight tolerances on manufacturing techniques.

The first assembly check immediately follows the winding of basic foil and paper elements. This test verifies the dry-insulation strength of the paper dielectric by applying a high-impulse voltage to each wound element and automatically rejects any unit which gives any indication of not meeting the strict insulation requirements.

Skilled operators assemble the wound elements into an internal pack, make the necessary electrical connections, and position the pack and its secondary insulation in the capacitor tank. A welding operation then seals the terminal bushing-cover assembly to the tank, which is followed by submerging the entire unit in a water bath. Introduction of pressurized air through the filler opening while the capacitor is under water provides the opportunity to inspect exterior surfaces for escaping air bubbles, a test so effective it locates even microscopic leaks in the capacitor housing.

Workmen now mount the leak-tested capacitors on autoclave trucks and prepare them for the prescribed heating and drying cycles which remove virtually all traces of air and moisture from the interior of the containers. In the final stage of the autoclave operation liquid dielectric, askarel, flows under pressure to fill the evacuated capacitors. The capacitors are unloaded from the autoclave and askarel samples are immediately tested for power factor and resistivity.

After cooling, a sealing operation closes the fill port and the capacitors move to the electrical test area. Here each capacitor receives a series of critical tests, the first being designed to determine the effective operation of the internal discharge resistors. This check confirms their specified capability of reducing the capacitor voltage to less than 50 volts in five minutes.

Next in the series is the minimum-voltage withstand test of the combined dielectric. A d-c voltage 6.25 times the capacitor nameplate rating is applied across the terminals. A dielectric breakdown marks the presence of conducting particles or flaws in the dielectric and the capacitor is discarded.

Last test of the group is verification of the minimum-voltage withstand of the secondary insulation. The two capacitor terminals are first joined, then high-voltage a-c is applied between the terminals and the aluminum case. Capacitors rated up to 5 kv must demonstrate an a-c withstand strength of 26 kv, while capacitors above this rating must withstand 34 kv a-c.

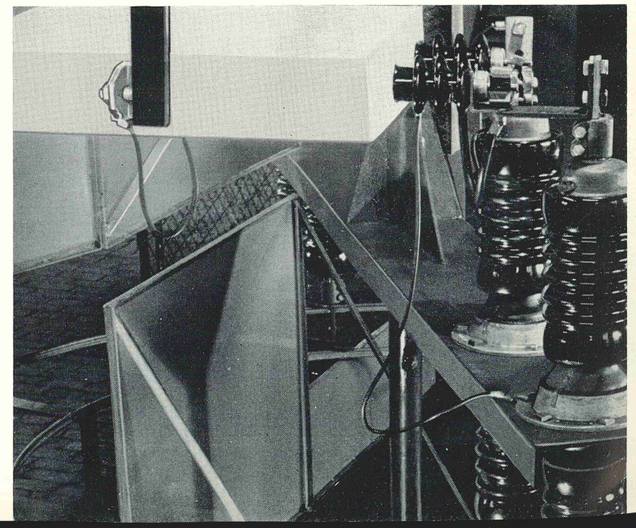
The final paint finish is now given each capacitor, after which the conveyor moves it through a drier to the final oven heating to 105 degrees C. At the conclusion of this cycle, a careful visual examination of each capacitor locates possible askarel leaks, particularly noticeable at this juncture because of the internal pressure developed within the sealed container by the high temperature.

Capacitance and power factor at rated voltage are measured for each capacitor while still at oven temperature. Capacitance of the finished unit at rated voltage cannot be less than its rating nor can it be greater than 115 per cent of its rating. Losses ascertained in this final portion of the electrical test schedule cannot exceed O-B's present maximum level of 1.95 watts per kvar at 105 degrees C.

Sample capacitors are withdrawn from each lot being tested and are given an additional watts loss test at 10 per cent rated voltage. This test constitutes a primary control over the factory assembly operations and any significant variation of internal loss characteristics requires that additional samples be immediately tested. Production is released only when a complete and valid explanation of the variation can be determined.

O-B's production facilities for the manufacture of capacitors conform to finely detailed engineering specifications which have been established through development tests and laboratory research. The stringent production-control tests which guide the manufacturing processes prevent any deviation from the high quality standards established. Emphasis on uniformity of construction augments engineering assurance that Varex Mark IV capacitors have built-in operating stability.

Production control card for each capacitor assures complete compliance with test limits.



Insulation strength of each element is verified before pack is assembled.

Application of high voltage a-c from case to joined terminals checks BIL.

"Accent on youth" issues challenge to future engineers and technicians

During this year's National Electrical Week February 7 to 13, we join the electrical industry in telling our mutual story to the more than 73 million youths in our society. Here is a mammoth future market for electric power, and for the engineers, technicians, and trained personnel needed to continue the industry's growth.

Careers in the electrical industry offer a great challenge and opportunity to the newcomer. Power demands are doubling an average of every ten years, creating new problems every day. To solve these problems, new products and methods are being introduced rapidly. Today, extra-high voltage, underground residential distribution, and electric heat are popular innovations. The future sees transmission at a million volts, nuclear generation, primary load center service at high voltage in each residence, luminescent lighting in walls and ceilings, and automatic seasonal control of temperature and humidity in offices and homes.

Few industries present as favorable a growth forecast as the electric power industry. We at Ohio Brass are confident in this growth, and are preparing by devoting three times as much money and effort to research and development as ten years ago. Our High Voltage Laboratory has been expanded three times in the same ten years, with addition of equipment like a four-million-volt impulse generator with built-in provisions for future expansion and a fourth 750-kv transformer.

Now, we must attract people to the electrical industry to accept the challenge and to continue the search for new products and methods. To do this job we must present the electrical industry story early in their life, and with enthusiasm. To quote O-B President Roger A. Black, "Let our excitement show when we recruit engineers . . . When excitement about the future shows throughout your organization and mine, it's also going to show when we sell our industry to those new engineers."

During National Electrical Week we at Ohio Brass would create an awareness of the industry story, and the challenges and opportunities available in it to our employees and communities. It's our way of supporting the electrical industry's "Accent On Youth."

NATIONAL ELECTRICAL WEEK

FEBRUARY 7-13, 1965

Practical deadends available for heavy-duty EHV crossings

Now under construction are quadruple-conductor anchorages rated at 600,000 pounds per phase

Most EHV lines are hundreds of miles long. Many of them tap remote power sources. These two factors often result in encountering stretches of unusually rough territory. The relatively high cost of an EHV project discourages making lengthy detours around natural obstacles such as waterways or deep valleys. Therefore, as more EHV lines are built, more interest is being attracted to the materials and techniques used in constructing heavy-duty crossings.

Furthermore, few EHV lines are now being built with single conductors. Bundles of two, three, and four sub-conductors per phase are the normal expectation. Many times, steel cables are used. These add heretofore unexpected tonnage to the deadend support.

Presently under construction is a river crossing of 5,900 feet, comprising bundles of four sub-conductors per phase. Each conductor has a diameter of 1.1 inch, using steel except for a single outer aluminum layer. Anticipated loading with wind and ice is 260,000 pounds per phase, supported on deadends each with an ultimate rating of 600,000 pounds. How is such duty handled by ordinary porcelain insulators?

First, let us go back a few years to 1951. Kootenay Lake in British Columbia was crossed with 160 kv, on spans whose supporting points were 10,656 feet apart. Single 1.25-inch steel cables served for conductors. Deadends have a working load of 76,000 pounds and a design load of 106,000 pounds with wind and ice. The deadend design proposed for this by O-B was based on a previous device built in 1928, which had a very successful operating history.

Principle of this deadend is illustrated in the accompanying sketches. A series of "whiffletree" yokes distribute and equalize strain on 12 strings of suspension insulators. For the Kootenay crossing, insulating units of 25,000-pound rating were used. Under normal conditions, these insulators encounter only 6,300 pounds tension per string. With wind and ice assumptions, the load increases to 8,830 pounds. Both such loads are well within the 12,500-pound normal working rating per string. Each deadend has an ultimate rating of 300,000 pounds. Safety factors are generous.

From the foregoing it will be seen that the present four-conductor crossing under construction is far from an experiment. Modern technology has raised mechanical ratings considerably, due to the recent introduction of O-B's 50,000-pound insulator. Twelve strings of these insulators result in the 600,000-pound ultimate strength, previously stated. The 260,000-pound maximum design load, assuming one-half inch of ice and a 60-mph wind, is within reasonable working limits on the deadends.

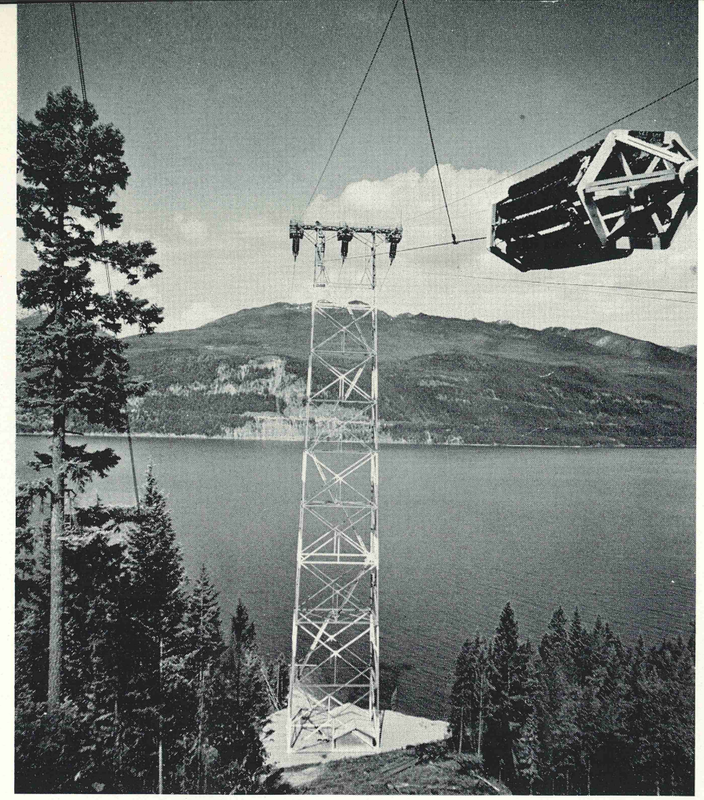
Figure 1 illustrates the principle of strain distribution in the massive deadend assembly. This has been sketched on a flat plane for more clear description. In practice, the construction forms a hexagonal cylinder with points (A) connected. The "whiffletree" yokes transfer strain through the mechanical system, and equally distribute this strain on each insulator string in the form of 1/12 of the total load.

In such critical duty as this, it is only conservative engineering judgment to assume the rare possibility of insulator failure. In such an event the condition shown in Figure 2 would occur. The two unloaded yokes would align with the strain and an instant redistribution of load would fall on the remaining insulators. This would be a load increase of only about 10 per cent per string, and would create no serious emergency.

A new insulator string would be inserted by drawing back the two yoke plates to normal position, or a little past normal, to allow for working slack. This is done by tensioning devices inserted at points (B-1) and (B-2) as shown by dotted lines in Figure 2. After the new string is installed, tension is released and the assembly is restored to its normal state.

This relatively simple procedure has seen an interesting application on the new construction mentioned. Each deadend assembly comprises 384 clevis type insulators rated at 50,000-pounds ultimate. With this and many more weight and tension considerations at the time of building the crossing, insulators in the deadend assemblies were omitted and replaced by temporary steel rods for weight reduction and convenience. These rods will remain in place until the span is finally tensioned, and then will be replaced one at a time by insulator strings as previously described.

Construction of spans of this magnitude is certainly no everyday occurrence and, in a few cases we have encountered, the mere anticipation of such a project tended to discourage the most advantageous routing of a line. We do not intend to imply that adequate and proved-out heavy-duty deadends for this purpose will eliminate all other problems, but it is possible the knowledge that such deadends are practical will allow consideration of a more desirable line location.



Kootenay Lake crossing, 10,656 feet between support points. The single 1.25-inch steel cable imposes a working load on deadends of 76,000 pounds, and a design load of 106,000 pounds with ice and wind. Ultimate strength of each deadend is rated at 300,000 pounds. Similar construction is now being applied to four-conductor bundles of steel on a 5,900-foot crossing with a design load of 260,000 pounds per phase, on deadends rated at 600,000 pounds. Knowledge that such heavy-duty equipment is available and entirely practical may permit more generally advantageous location of a line.

Figure 1 -- "Whiffletree" principle of multiple-string deadend that multiplies by 12 the strength rating of insulators used. In practice, this arrangement forms a hexagonal cylinder with points (A) joined. Load is divided and equally distributed on insulator strings.

Figure 2 -- Failure of one insulator string does not incapacitate the deadend. Yokes align to the strain and load is re-distributed with only about 10 per cent increase on the remaining insulators. Tensioning devices temporarily inserted at points (B-1) and (B-2) bring yokes back into normal position for installation of new insulators.

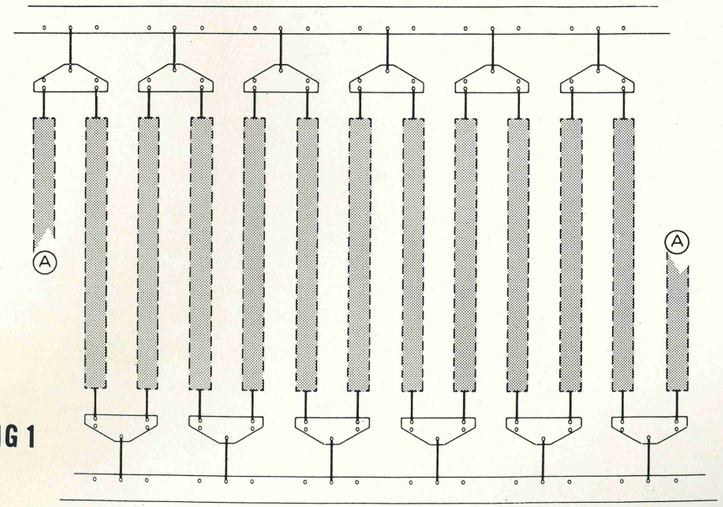


FIG 1

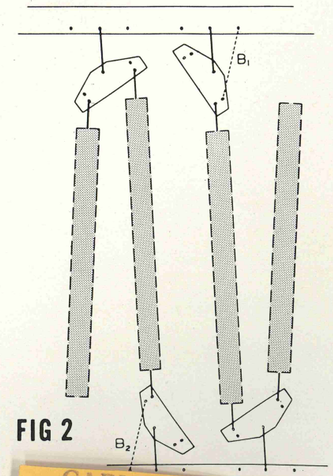


FIG 2

CARL FORSYTH
INSULATOR DEPARTMENT
GENERAL ELECTRIC COMPANY
P. O. BOX 10583
700 TUCKASEEGEE ROAD
CHARLOTTE , NORTH CAROLINA 28201

OHIO BRASS MANAGEMENT REPORT

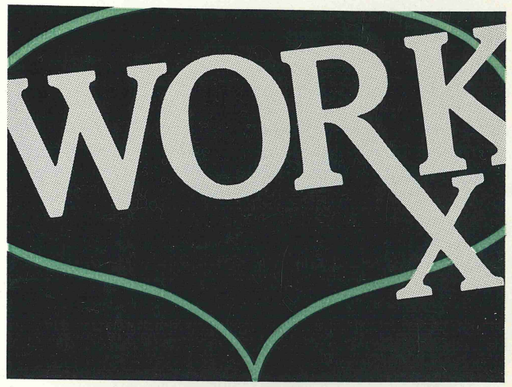
A lone voice advocates work as our cure

BY ROGER A. BLACK
PRESIDENT, OHIO BRASS COMPANY

Asked what she had enjoyed most during 25 years in the House of Representatives, Congresswoman Frances Payne Bolton of Cleveland recently answered "work." Yet this vigorous 80-year-old may soon be voting on legislation which would require double pay for overtime, and next, on a bill to limit the work week to 35 hours . . . measures spurred, no doubt, by admirable motives yet still limiting the opportunity to work because they increase the cost of labor.

AT THE SAME TIME we hear our young people called "the twisted generation" because they openly admire the manipulator as opposed to the man who gets ahead by merit and hard work.

WHO TAUGHT THEM THIS? The older generation did it, not by design, perhaps, but through a great desire to create more leisure time, to free people from the burden of labor. Now I wonder whether we haven't robbed them rather than freed them. Have we oversold the benefits of leisure? Are we making it harder to learn that work can be rewarding in itself, not necessarily because of the size of the paycheck; that accomplishment, in pleasing yourself, not just pleasing the boss, can bring a glow of satisfaction unmatched by the thrills of a dozen weekends on the ski slopes or the golf course?



MANAGEMENT FEELS COMPELLED to apologize when it questions proposals that increase wage costs. This is not the popular position. But I think it's more than a management problem. It's a problem for all society. All management can do is pass along the cost to its customers. Society has to pay the price, not your company or mine, although we may be the unwilling collection agencies. Even so the price in dollars is small compared to the price in discontent in the mind of an employee who wonders why his life lacks direction.

I SUGGEST THAT management turn its talents to merchandising the value of productive work . . . of rediscovering the joy that comes from doing the job that the boss says is impossible. Perhaps we can help people to learn that work is not a burden imposed upon them by management. Real work can be hard, but it also can be rewarding, it can be fun, it can be therapeutic. In fact, some people might even conclude that "happiness is a thing called work." 737-H

OHIO BRASS COMPANY • MANSFIELD, OHIO
Canadian Ohio Brass Co. Ltd. • Niagara Falls, Ontario

OHIO BRASS

6524-H Printed in U. S. A.

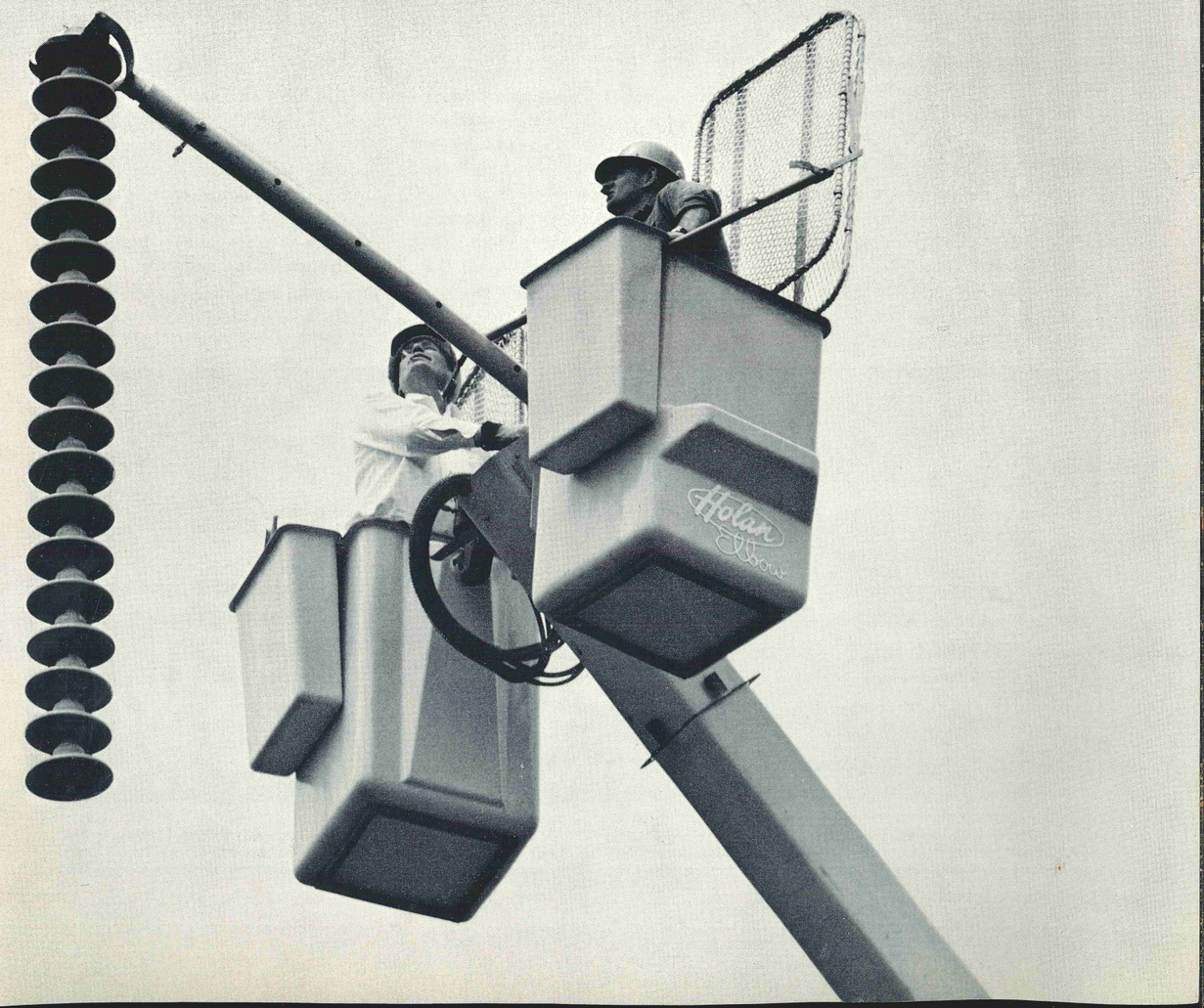
OHIO BRASS

HI-TENSION NEWS

PUBLISHED BY OHIO BRASS COMPANY, MANSFIELD, OHIO - VOL. 34, NO. 6 - JUNE 1965

Received from C. Forsythe 6/24/65 MLS

Holan Elbows perform "extra" work with optional equipment. Gin pole with dishpan attachment simplifies changeout of insulator string at 345 kv. See page four.



Malleable iron hardware offers many desirable properties

Malleable iron has attributes which particularly recommend it for service on all power conductors, including those for distribution voltages. While nonferrous metals have attained popularity in recent years, they cannot detract from some of the basic merits of malleable iron.

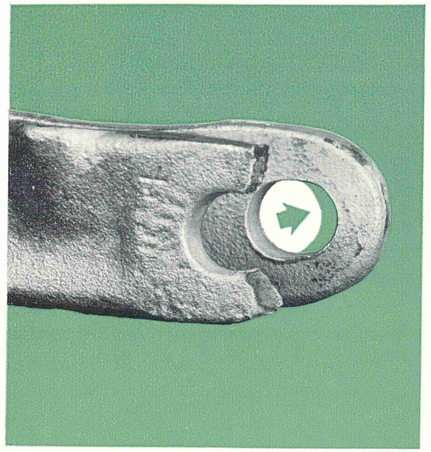
Malleable iron combines excellent strength characteristics with high ductility. On test as well as in field service, it withstands deformation, stretching, and abrupt bending without fracture. In emergencies, conductor clamps will retain their grip and provide support under extremes of abnormal loading. Malleable is ideally suited to the manufacture of hardware fittings.

In its molten state, when it is cast, this metal has the valuable property of fluidity. Certain other metals never become more fluid than a heavy syrup; they do not follow the intricate shapes of a complex mold, imposing a severe restriction on product design. Conversely, malleable iron is very "thin" in its molten state and imposes very few limitations on shape, thickness, or design detail. It will take the shape of almost any mold with a high degree of fidelity. Development engineers can conceive the most desirable form for a piece and be assured that malleable iron will provide its accurate interpretation.

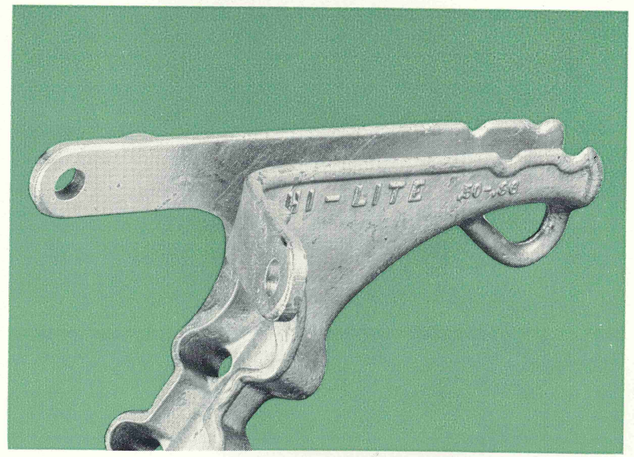
Resistance to corrosion is one of malleable's most important properties. This is due to the formation of a tenacious oxide coating when the piece is exposed to the elements. In this manner, rusting *does* occur. But it is not progressive, and the metal is self-protecting to a considerable degree. Other ferrous metals exposed to weather will rust, flake off, and rust again, until the product may lose sufficient material in critical areas to affect its mechanical strength.

All O-B malleable iron products are protected by a thick, hot-dip galvanized coating. In addition to cleanliness and good appearance, the H.D.G. coating provides a lasting primary preservative for the base metal. In exceptional cases of prolonged exposure to chemical contaminants, where the galvanized coating is attacked, the corrosion resistance of malleable iron will extend the life of the product almost indefinitely.

Malleable iron is standard or optional in such O-B equipment as: Universal clamps, Strateline clamps, Hi-Lite strain clamps, clamptops, suspension insulator caps, suspension clamps, hardware fittings, and a variety of miscellaneous hardware for transmission and distribution line applications.



Under tremendous stress, malleable iron strain clamp takes considerable deformation and stretching prior to failure. Note the extent of elongation in the rivet hole before fracture.



Malleable iron strain clamps withstand abrupt bending without fracture -- on test and in field service. Malleable iron combines excellent strength with high ductility.

One Varex feature remains the same

Special studs prevent permanent damage to capacitor terminals

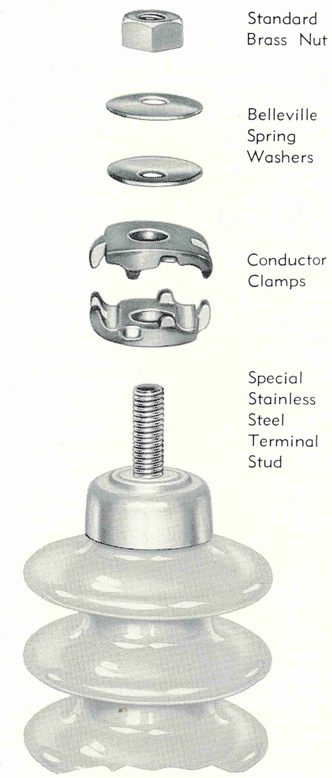
O-B Varex capacitors are in their fourth generation in respect to major design progress. The Mark IV of today represents a multitude of significant engineering and production advances. Its balanced operating characteristics are the outgrowth of constant evaluation and use of improved materials, changes in internal arrangement and assembly, and pronounced reductions in voltage stress, temperature rise, physical size, and weight.

Yet, during all this design endeavor and years of field experience, nothing has changed or improved the user benefits of the standard brass nut and non-strippable stainless steel terminal stud assembly. In very simple terms this feature, which was introduced on the first Varex capacitor and is still furnished on current production Mark IV capacitors, means that if the terminal nut is overtightened and stripped, you throw away the nut -- not the capacitor.

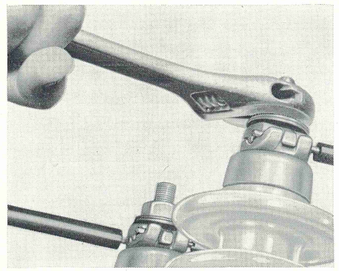
The combination of regular brass nut, special stainless steel stud, and Belleville washers makes it easy to get the right pressure on the conductor without resorting to special torque wrenches or indicators. It takes just 10 foot-pounds of torque to flatten the Belleville springs -- a visual sign that proper clamping pressure of over 1000 pounds is applied to the conductor. You can also feel the rapid increase in torque which occurs immediately after the washers flatten, but if both these indications are unnoticed or ignored, the threads of the brass nut strip at a torque of 35 foot-pounds, long before any damage can be done to the threaded stud.

Experimental tests have been run with special tool steel nuts to determine the torque required to break or strip the threads of the terminal stud. The 90-foot-pound torque required indicates that the safety-strip feature gives an insurance factor of almost three to one against damaging the capacitor stud. Additional tests have shown that to break the porcelain terminal bushing, a force of 250 foot-pounds or more is required.

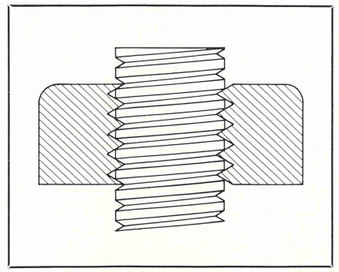
The terminal stud is a small part of the capacitor assembly, but, if broken, is usually irreparable. Mark IV Varex capacitors guard against this possibility by providing adequate margins to cover variations in field installation, backed by the ultimate protection - that the nut destroys itself before damaging the stud.



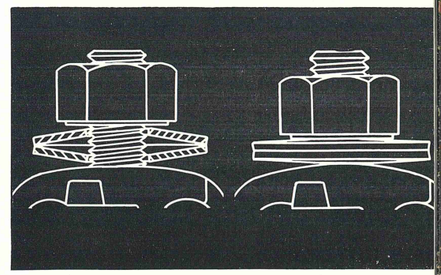
Mark IV Capacitors incorporate field-proved Varex design terminal assembly.



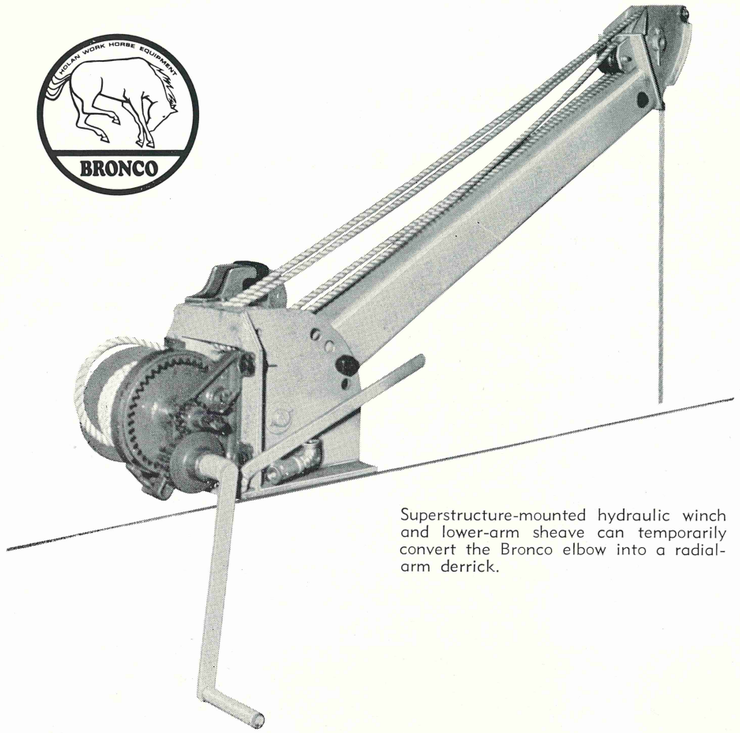
Not only do the Belleville washers provide a visual indication of proper pressure on the conductor, but you can actually feel the increase in torque as you turn the wrench.



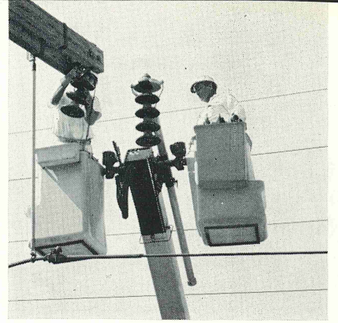
Brass nut has standard threads and is easily replaceable. Thread-stripping safety feature is provided by removing the crests of the stainless steel terminal stud threads.



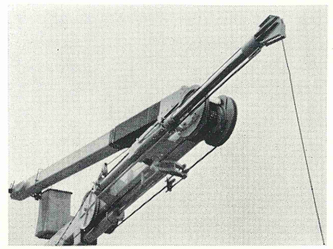
With 10 foot-pounds of torque applied, the Belleville springs flatten, indicating the proper clamping pressure is applied to conductor.



Superstructure-mounted hydraulic winch and lower-arm sheave can temporarily convert the Bronco elbow into a radial-arm derrick.



Dishpan attachment on the end of a standard-equipment gin pole picks up string of suspensions during changeout of broken insulators.



Many Holan Broncos are equipped with a "stinger" -- an hydraulic extension of the sheave head beyond the lower arm for greater working height.

"Extra" work pays its way

Optional attachments for Holan Bronco elbows add loading-handling, lifting, and winching capabilities

A savings in time and manpower results when a single piece of equipment handles auxiliary tasks in addition to its prime function. That's why many utilities have equipped their Bronco elbows with optional attachments that greatly increase ability to handle aerial loads and serve as derricks.

Most Holan elbows can be equipped with an optional superstructure-mounted hydraulic winch and lower-arm sheeve arrangement. This, in effect, makes the equipment an aerial device and a radial-arm derrick.

It is a truly versatile derrick, capable of 75 degrees or more of elevation and full 360-degree rotation. Also, a "stinger" -- which permits hydraulic extension of the sheave head beyond the end of the lower arm for greater working height -- is available on many models of the Bronco.

Few optional devices have proved themselves as essential in aerial work as Holan's gin pole, a fiberglass-reinforced plastic boom with a lift capacity of over 2,000 pounds at 75 degrees or more from the horizontal position.

The gin-pole boom, with the same insulating qualities as the elbow, mounts between the buckets at the end of the upper arm and operates through a 150-degree or 360-degree vertical range and extends up to six feet.

Considered an essential tool for application of the O-B Live Line Barehand Method, the gin pole lifts and holds conductor spans, picks up and positions loads aloft—such as crossarms, insulators, switchgear, and transformers.

Precise positioning of aerial loads is quick and easy with Holan's transformer-handling device, a fiberglass-boom and hand-winch mechanism which attaches to the top of the upper arm. The boom pivots and relocks on a quadrant plate, and the line is controlled by a handwinch. These movements, coupled with arm elevation, provide infinite angles of elevation and make possible pinpoint positioning of 600-pound aerial loads.

For more information about any of these load-handling options for Bronco elbows, write Holan Division, The Ohio Brass Company, 4100 West 150th Street, Cleveland, Ohio 44135.

Before you get an O-B insulator we've tried 2,036,000 times to ruin it

Fresh out of the firing kilns, before the start of any assembly operations, the porcelain discs of O-B suspension insulators go onto a moving endless conveyor. This is the start of a five-minute trip that people have compared to "the back door of hell." The noise and fireworks are frightful!

First, the insulators pass under an electrode that gives them five seconds of 200,000 cycles, at flashover voltage. Next, they spend the balance of five minutes traveling under electrodes charged at 60-cycle flashover voltage. Total half cycles to which the insulators are exposed add up to the figure of 2,036,000 . . . any one of which can produce puncture in a substandard piece.

Since a vigorous flashover voltage is used in all cases, the dielectric strength of the parallel air path has been exceeded. This means that the insulation has been exposed to the maximum voltage that can be built up in air at the test frequency used.

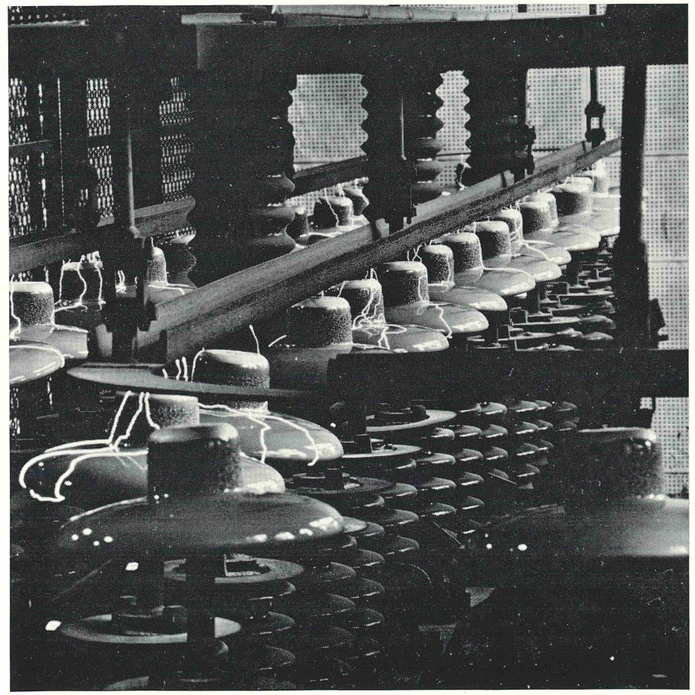
In the event of electrical puncture of a piece, the resulting short circuit in testing voltage gives immediate indication of the failure and temporarily shuts down the testing line until the defective piece is removed and its support is disconnected from ground. No more elaborate provisions are needed, because failures occur so seldom.

On close examination of a suspension insulator it is sometimes possible to detect some of the tracks of flashover on the glazed surface. The glaze has suffered no harm, but this proves the potency of the voltage source used in this severe test.

Since any single insulator on a transmission line is exposed to flashover voltage only once in many years, it is abundantly true that it spends by far the hardest day of its electrical life in the factory.

Many users of suspension insulators take the realistic view that this product is manufactured by the millions and at a highly competitive price. Because of this the question arises, "Do they get individual attention or are they turned out like so many nuts and bolts?"

No matter how many we make, or how many you connect in series . . . whether your application is low voltage or EHV . . . each insulator must survive service under the combination of voltage and time it will experience. In view of this it behooves us to test them as if each unit were the only insulator we ever produced. This is exactly the point of view of O-B production men. And to put meaning into what might otherwise be merely a claim, electrical failures of O-B insulators in service run less than one in 10 million . . . solid proof that we do have a sound design, accurately reproduced, and thoroughly tested . . . the best performance record, to our knowledge, in the industry.

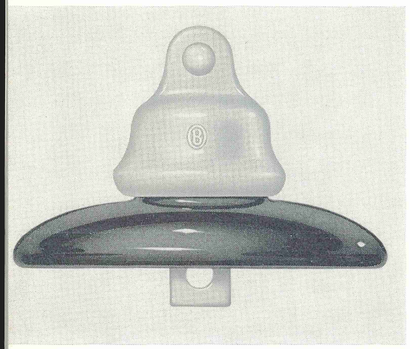


Portion of the endless conveyor that gives every O-B suspension insulator disc a five-minute exposure to full flashover voltage. Five seconds of this test is at 200,000 cycles; the remainder at 60 cycles. This eliminates any defective pieces before they go to assembly. Note that the absence of the cap in this test extends the striking distance over the porcelain, and increases flashover voltage beyond that which is normal for the assembled insulator.

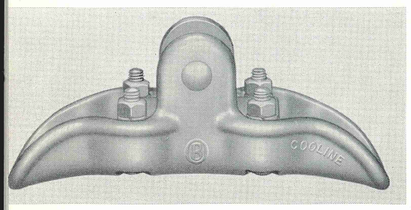
Insulators and hardware in an interdependent system . . . from Ohio Brass

O-B assumes responsibility for your complete insulator-hardware system from design to delivery

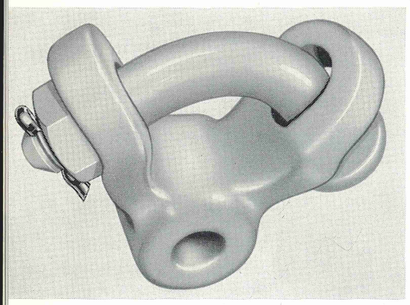
O-B design engineers combine suspension insulators **(1)**, controlled-radius clamps **(2)**, wye-clevis fittings **(3)**, and a stabilized yoke to form an integrated insulator-hardware system **(4)**. Each component performs interdependently with the remaining system elements.



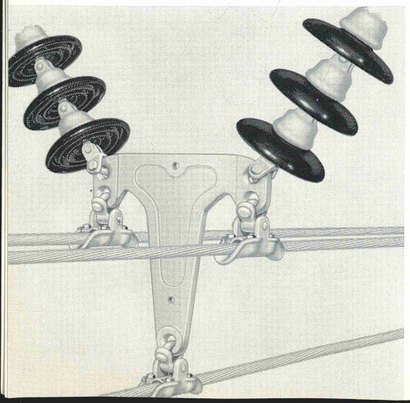
1



2



3



4

Where's your best buy in the EHV marketplace? For line insulators and hardware, you'll find some companies make insulators only; others yokes, clamps, and fittings. However, Ohio Brass is the *one* manufacturer that makes and sells a *complete* suspension system -- insulators and hardware -- designed, manufactured, and tested as an integrated system.

O-B's design engineers for transmission insulators and hardware work together developing a new EHV line's insulator-hardware system. They've worked this way successfully for EHV systems now operating, and for 345-, 500-, and 735-kv projects where O-B is currently supplying materials. Their total EHV experience record dates back to the first 345,000-volt line energized in 1953 which introduced modern EHV transmission. O-B engineers know from first-hand experience how EHV lines perform, and are constantly learning and developing new design procedures for them.

Close coordination and cooperation during development results in a refined design. The final assembly fits together naturally, performs like a unit mechanically, and exhibits optimum RIV and corona characteristics. Use of O-B's performance-proved suspension insulators, controlled-radius clamps, wye-clevis fittings, and stabilized yokes offers further assurance of a competent system design. If a design problem develops, it's worked out among the design engineers.

Application of design principles outlined in O-B patents permits development of a ringless multiple-conductor insulator-hardware system. Bundled conductors surround the critical line hardware to stimulate a Faraday cage and accomplish the previous grading function of rings. Stabilized yoke design adds another benefit covered by O-B patents. The insulator string attaches to the yoke inside the bundle area, at a point located relatively close to the insulator-hardware system's center-of-gravity. When mechanical transients hit the support points, the complete assembly rotates on an axis about the attachment point and remains stable, returning to the normal position after the disturbance subsides.

All preliminary research and design testing is conducted in O-B's High Voltage Laboratory, with its diverse facilities for mechanical and electrical experimentation. In the Mechanical laboratory, basic strengths are established for components and the complete assembly. Preliminary electrical tests may be conducted in the indoor Electrical laboratory, while a complete assembly may be erected in the outdoor Electrical laboratory and tested with full-scale voltages in an actual or simulated tower structure. O-B's all-weather, four-million-volt impulse generator reproduces lightning and switching surge effects for realistic line performance data under all conditions.

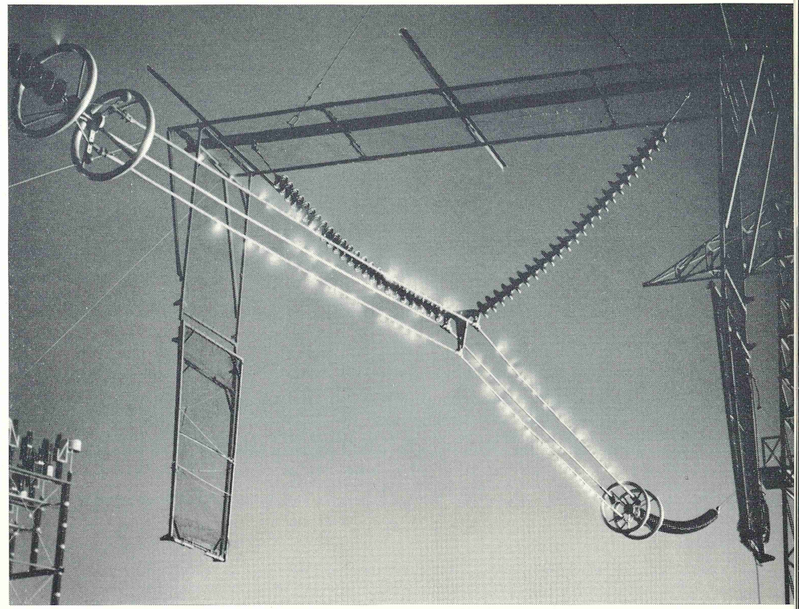
O-B continues to offer more after final design approval. The entire insulator-hardware assembly is manufactured in O-B facilities where EHV manufacturing experience parallels the background of O-B engineering. We control the complete manufacturing operation for each component. Yokes, clamps, fittings, and insulator caps and pins are manufactured in O-B's Mansfield, Ohio, plant. An hour's drive away in Barberton, Ohio, porcelain discs combine with cap and pin to produce O-B suspension insulators. Rigid quality control maintained during each manufacturing operation in both plants assures the final quality of O-B's complete insulator-hardware system.

O-B's job isn't over after manufacturing. For many new EHV projects, we package hardware components in the required quantities for each tower. Insulators are packed in combinations that handle easily and connect conveniently into string quantities. A standardized number and type of packages per tower simplifies delivery to construction sites, and eliminates confusion for line personnel.

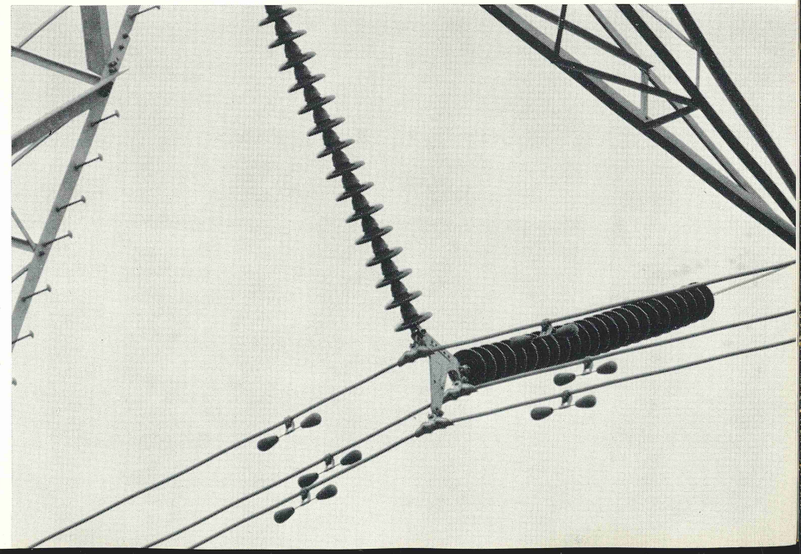
Another service O-B offers when supplying large quantities of insulator-hardware systems involves coordination of construction logistics with manufacturing. If we know your construction schedule and location of marshaling areas, we'll ship materials sufficiently ahead of construction. You'll have a minimum of stock to handle and materials will be waiting when your construction crews move to a new marshalling area.

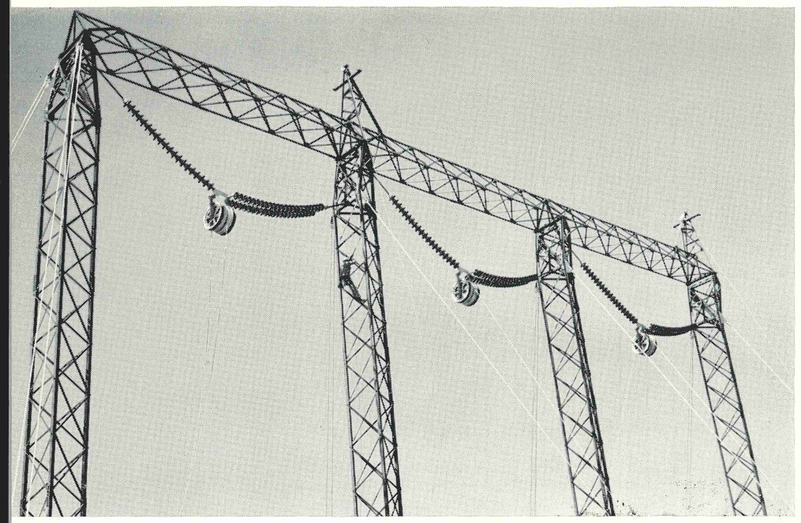
When you specify a complete O-B insulator-hardware system for your new EHV line, you get one source of supply and responsibility for delivery, a system designed to your specifications whose components perform interdependently, and the O-B High Voltage Laboratory at your disposal for proof testing. O-B provides these services for your convenience. Let us add your new line to O-B's growing list of over 4,000 miles of EHV success stories.

Complete research and design proof-testing is conducted in the O-B High Voltage Laboratory, with its indoor and outdoor Electrical sections and a complete Mechanical laboratory.



From the design stage, through manufacturing and testing, to delivery to your tower site, O-B controls all operations which result in your **complete** insulator-hardware system.



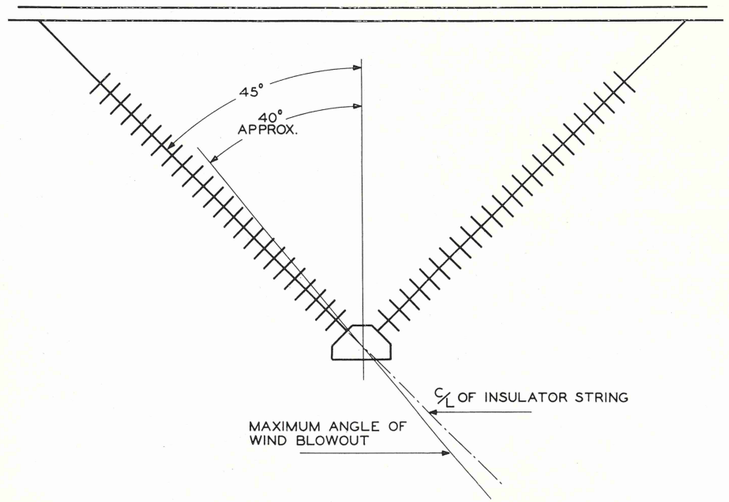


An interesting example of wide-angle V-string construction for special conditions, and requiring high strength in the insulating supports. This seven-degree corner tower is on a hilltop in mountainous terrain. Long spans each drop about 100 feet on either side to towers on lower elevations; therefore, this structure must support tension of the corner plus abnormal conductor weight. Strain runs toward the reader's left, and is taken on double strings of 36,000-pound insulators. The inner leg of the "V" is built with single strings of 50,000-pound units.

Angle of V-string mainly determined by maximum computed wind

Built slightly wider than conductor blow-out angle to prevent mechanical unloading

Angle of the V-string should be slightly greater (approximately five degrees) than the maximum computed angle of horizontal wind displacement of the conductor. Here, the maximum displacement is figured at 40 degrees, and legs of the "V" are at 45 degrees.



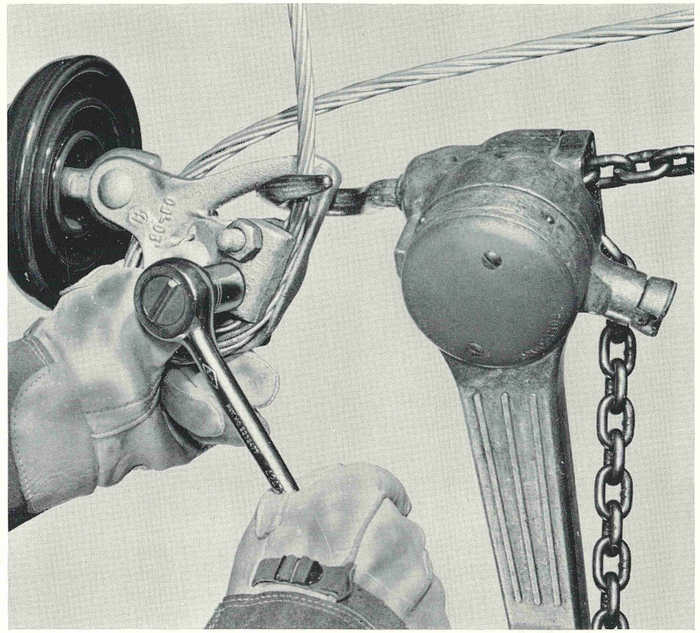
Engineers contemplating design of a new EHV system sometimes ask, "Is there a conventional or an accepted angle for the construction of V-string?" The answer to this question is "no."

As one goes back in the history of V-strings, and this spans many decades, the angles were often narrow compared to today's practices. Sixty degrees was not uncommon. The fact that these supports are still in service certainly proves that they were not badly engineered, even though modern construction tends toward a wider angle.

Choice of angle is dictated by the avoidance of an unloading condition of the lee string in maximum computed side winds. From a standpoint of welfare of the insulators, slight unloading is not harmful . . . providing there is some agreement on the definition of the word "slight." A few inches of sag away from a taut condition of the string is readily tolerated, whereas a collapsed string might possibly cause contact of the porcelain discs, and attendant breakage. While ball-socket connections of insulators are locked against uncoupling by a secure cotter key, there is always the chance that the key may be deformed, resulting in parting if the string was sufficiently unloaded. This of course does not apply to clevis connections.

No unloading will occur as long as the angle of each leg of the "V" is greater than the maximum blow-out angle of the conductor. One common assumption of blow-out is 40 degrees in either direction. In such a case, V-strings are built at 90 degrees, allowing a five-degree safety margin on either side. Such construction is probably very conservative, especially outside hurricane regions. Most EHV conductor systems consist of two or more relatively heavy cables that take considerable wind to cause more than moderate horizontal displacement. The 90-degree "V", however, is extensively used and seems to assure full loading of the support under all conditions.

Going back to the original question, "Is there a conventional or accepted angle for V-strings?" it might be answered by saying that while 90 degrees has considerable popularity, we hope to have pointed out that this angle is not sacred. It is equally sound to take history and local conditions into account, and merely assure a continuously loaded condition of the "V" by building it approximately five degrees wider than the highest computed angular displacement of the conductors in maximum side winds.



Clamp jaws are held apart in full open position by a spring on Universal Clamp Number 88500, with no loose pieces and nothing to take apart or put together.

O-B distribution clamp lends a hand to linemen

Special spring holds open jaws on Universal Clamp No. 88500, one of O-B's popular made-of-malleable clamps

Here's a distribution clamp that could easily become known as the lineman's helper. It's the Ohio Brass Universal Clamp Number 88500 -- manufactured of malleable iron, an ideal clamp metal, resistant to corrosion and highly ductile with good resistance to impact damage.

This O-B clamp has its unique advantages and fits the needs of most distribution systems. The Number 88500 holds conductor diameters of .20 inches to .50 inches, has an ultimate strength of 10,000 pounds, and weighs about 2.5 pounds. This clamp's strength equals or exceeds that of most conductors it will hold.

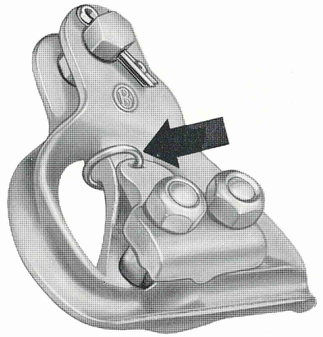
(Continued on next page)

(Continued from previous page)

Spring jaws on the Number 88500 are an exclusive and patented O-B feature. A light spring tension holds the jaws in open position. This enables the lineman to string cable through the clamp jaws without holding them open -- like giving the lineman an *extra* hand.

The clamp never needs to be taken apart; it goes from the manufacturer to installation in one piece. This eliminates awkward dropping of parts that become lost at night, in grass, or in snow.

However, the jaws of the Number 88500 do not have to be overworked. The circular body of the clamp produces a very effective snubbing action that never changes. When this clamp is removed from a conductor, only a slight dent in the cable indicates where the jaws have been. The conductor lies in a natural position for quick forming. This may save a minute or two of labor.



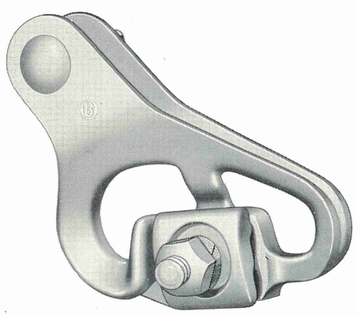
Special, stainless steel spring; see arrow.

Sharp hardware points energized at line voltage can cause radio influence voltage. Ohio Brass chamfers the bolt ends and clamping nuts on its hardware. This feature is also welcomed by linemen in preventing cut fingers or "barked" knuckles during line work.

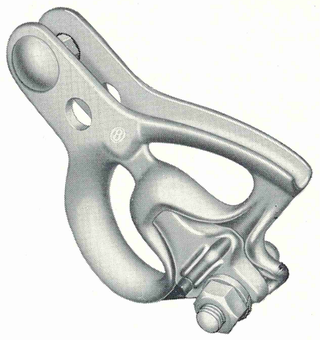
Hexagonal clevis rivets on O-B Universals increase contact-point pressure and reduce RIV. Humpback design of O-B cotter keys permits the cotter to be slipped into the rivet without the need for spreading. If the clamp is worked with hot-line tools, the key is easy to insert and withdraw. But it will never *fall* out. Pointed ends facilitate installation.

Line crews appreciate working with Ohio Brass Universal Clamps. Ask your O-B or Graybar representative for more information about the O-B Universal 88500 and other O-B distribution hardware.

Other O-B Universal Clamps



Number 80500 - weighs 1.3 pounds and effectively holds conductors with diameters ranging from .12 inches to .38 inches; ultimate strength of the clamp is 8000 pounds.



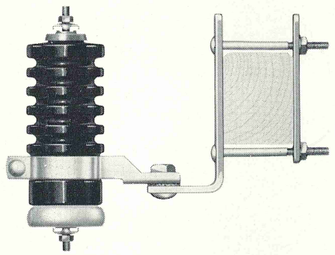
Number 81500 - has a reversible clamping piece; conductor diameters range from .16 inches to .44 inches; ultimate strength is 10,000 pounds; each unit weighs 2.3 pounds.

Number 78500 - offers a reversible clamping piece with a U-bolt fastening assembly. Clamps weigh 3.9 pounds and are rated at 14,000 pounds utlimate strength. Conductor diameters range from .16 inches to .55 inches.

Versatile hanger and EEI-NEMA crossarm bracket simplify pole top mounting of Multiresters

THOREX® MULTIRESTER

Most widely used pole top mounting accessory for Thorex Multiresters is the EEI-NEMA standard crossarm bracket assembly. The complete mounting device consists of a suitable arrester clamping ring firmly bolted to the EEI-NEMA universal-type angle assembly which provides ample flexibility to adjust the location of the arrester terminal in accordance with installation requirements. Bracket angle can be inverted to secure maximum height of arrester.



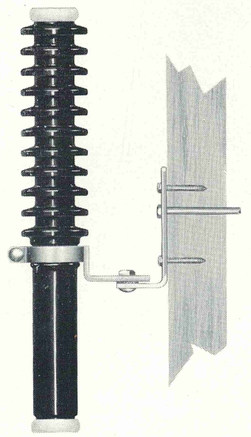
EEI-NEMA crossarm bracket provides sturdy, universal-type mounting facilities for all kv ratings of O-B Multiresters.

Two lengths of arrester clamping ring hangers are furnished to mount Multiresters. In ratings from 3 through 20 kv, clamping ring positions center of arrester 4¼ inches from bracket connection. On distribution arresters above 20-kv rating, the clamping ring furnished provides an additional 1¾-inches spacing from the crossarm. Design of clamping rings permits removal and replacement of the arrester without disturbing the mounting of the crossarm bracket.

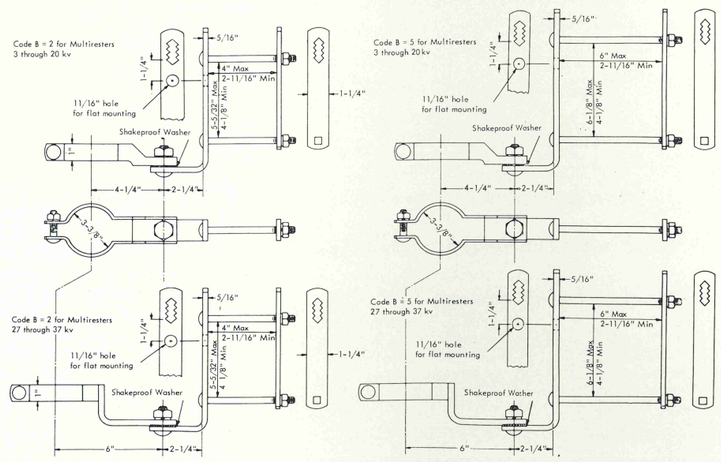
In selecting EEI-NEMA crossarm brackets for mounting Multiresters, it should be noted that two sizes are available. The standard size fits crossarms up to 4 x 5 inches in cross section, while a non-standard oversize assembly fits crossarms up to 6 x 6 inches.

A further modification of EEI-NEMA bracket exists in the option by which the assembly can be ordered or used without the two through bolts and the back plate, thus obtaining a simple angle bracket which adapts to face mounting on flat surfaces or back-to-back mounting with cutouts. All EEI-NEMA bracket angles have an additional 11/16-inch diameter hole located approximately one inch above vertical center for the purpose of fastening the assembly by means of a single through bolt or lag screw.

O-B Catalog 43 illustrates and explains the simplified suffix code system for specifying optional attachments for all ratings of Multiresters. Portion of suffix code for ordering a Multirester equipped with standard EEI-NEMA bracket for 4 x 5 crossarm is B = 2, which in combination with kv rating of Multirester automatically provides the proper length clamping ring. Similarly, the code B = 5 specifies the EEI-NEMA bracket for crossarms up to 6 x 6. Code B = 4 has been assigned to the EEI-NEMA face-mounting angle bracket and omits the through bolts and back piece.



EEI-NEMA bracket can be ordered without back piece for pole top or surface mounting. Additional 11/16-inch-diameter hole in angle piece permits use of ⅝-inch through bolt.



OHIO BRASS MANAGEMENT REPORT

How yesteryear decisions affect delivery schedules today, tomorrow

BY ROGER A. BLACK
PRESIDENT, OHIO BRASS COMPANY

You or someone else at your company has probably asked, "what has O-B done lately about speeding up insulator deliveries?" We have done many things lately but I suggest it's not so much what we have done lately but what we did several years ago that really counts. Here's why:

IN 1959 WE PLACED in operation the nation's first facility for mechanized forming of suspension insulator discs. The decision to build the facility had been made two years earlier. The intervening time had been spent on designing special machinery, developing a manufacturer for the machinery and putting up a building to house it. After we began to operate, it took another year to achieve maximum efficiency. So it took three years before an idea became a producing reality.

IN 1962 WE FURTHER AUTOMATED our malleable iron foundry to provide metal-forming capacity to match our porcelain capability. Again, it took considerable time to get this facility to maximum production efficiency. But we had the time. In those years, the pressure exerted on electrical manufacturers by incoming orders was extremely light. In fact, less than 18 months ago we were making automobile door hinges to give the foundry some needed work load.

TODAY WE MUST CONSIDER what additional facilities are needed to handle your demands of tomorrow, recognizing that expansion plans won't solve today's problems but tomorrow's. In making our plans, we continue to be puzzled by the erratic pattern of demand. The barometers of the electric utility industry—generating capacity added, new customers, kwhr sales — have risen steadily since World War II. Yet demand for insulators has fluctuated violently and rapidly between extreme peaks and valleys. So we ask: "how long will today's high level of buying persist?" An accurate answer will be

hard to find, just as demand was hard to forecast in the 1957-1962 period. Our decision to expand then was based on confidence in the future of the industry, rather than a precise forecast. Today's decisions will be made on the same basis. To solve the immediate problems we're concentrating on getting the most out of what we have . . . by adding people and shifts, by installing new machines and other facilities to relieve bottlenecks, by efforts to increase productivity and cut losses.

ALL THIS HAS HELPED second quarter shipments of suspension insulators 10 inches and above to rise 60 per cent in the second quarter over the same quarter in 1964. Even our increased suspension capacity hasn't been able to keep up, but it is gaining. On the bright side, we can be thankful for the way customers are cooperating in anticipating their needs and placing orders well in advance of expected delivery. We are also cheered by the knowledge that we anticipated, at least partially, the scope of today's demand and had effective capacity ready when it arrived. We must now anticipate the next peak and get ready for it. 742-H

OHIO BRASS COMPANY • MANSFIELD, OHIO
Canadian Ohio Brass Co. Ltd. • Niagara Falls, Ontario

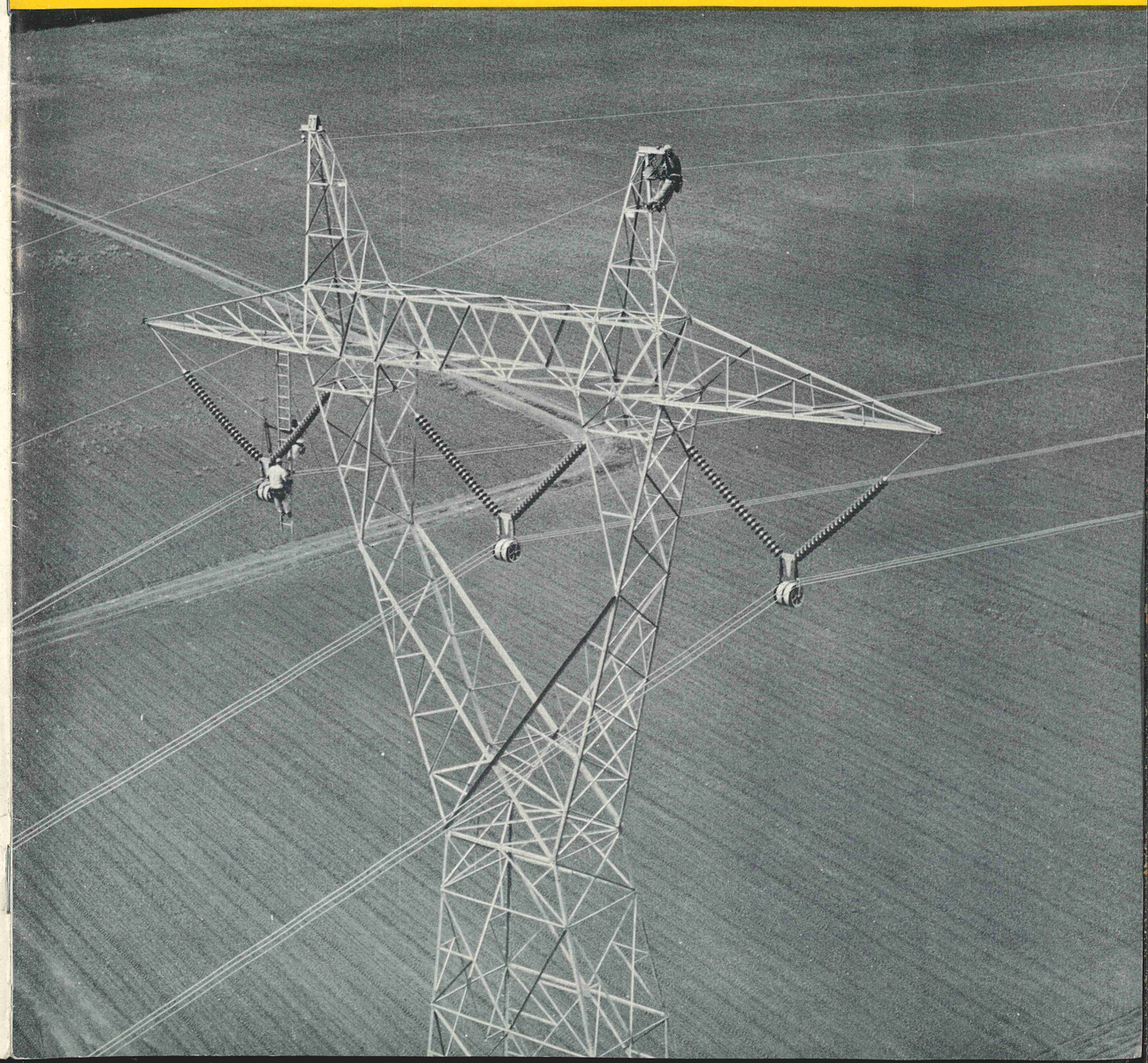
OHIO BRASS

6529-H Printed in U. S. A.

OB

HI-TENSION NEWS

PUBLISHED BY OHIO BRASS COMPANY, MANSFIELD, OHIO - VOL. 34, NO. 11 - NOVEMBER 1965

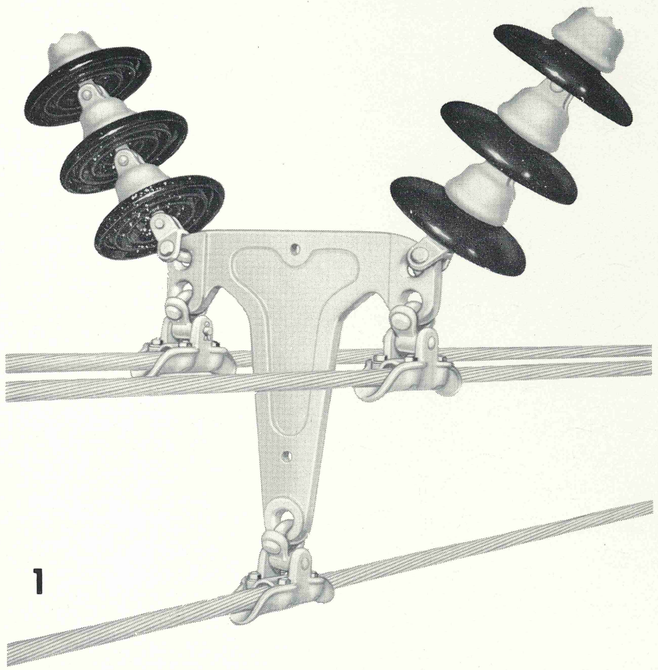


Arkansas Power & Light Company uses Three-Conductor Bundles on 500 kv

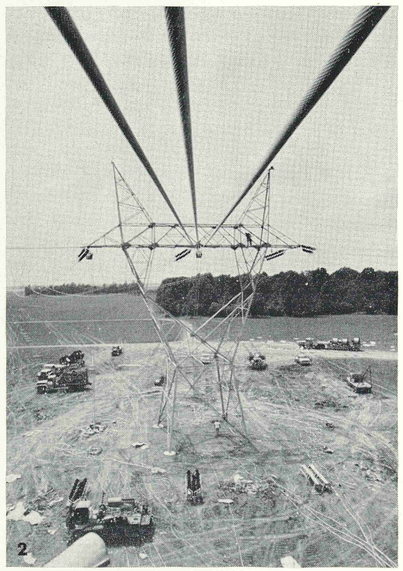
EDITOR'S NOTE

The April, 1965, issue of HI-TENSION NEWS carried an article on the Arkansas Power & Light Company section of South-Central Electric Companie's (SCEC) extra-high-voltage network. While it contained the essential information, the article lacked photographs of the construction.

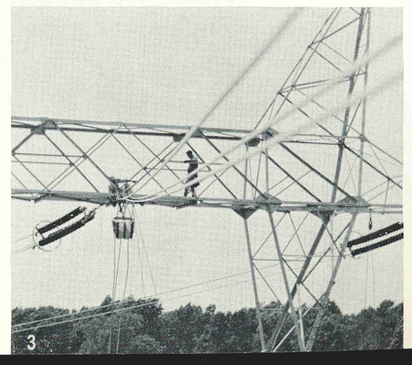
With the return of better weather we have been able to obtain the needed pictures and feel that they may be of considerable interest, since they illustrate building triangular three-conductor bundles for 500-kv service.



1



2



3

1. Detail of three-conductor bundle suspension. All line hardware and insulation for the 358-mile, 500-kv Arkansas Power & Light Company construction were furnished by O-B.

2, 3. Two views of deadend construction. Note in the lower foreground the racks containing triple insulator strings ready to be raised into place. By using three yoked insulator strings, it is convenient to attach one string to each of the three conductors and produce a very practical deadend arrangement. Insulators used for this purpose are ball-socket type of 36,000-pound rating. Conductors are strung at a tension of 5,090 pounds maximum.

Eleven investor-owned power companies have combined their resources to build the SCEC (South-Central Electric Companies) network. The majority of the 1,160-mile system will operate at 500 kv.

Arkansas Power & Light Company is now well along with construction of its 358-mile portion. This will be energized at 500 kv, on bundles of three conductors.

In reviewing pictures of this construction, the following statistics of the line may be helpful.

Conductor:

ACSR 1.165-inch. Stringing tension, 5,090 pounds maximum. Ground clearance, 33 feet minimum. Ruling span, 1,125 feet.

Insulation:

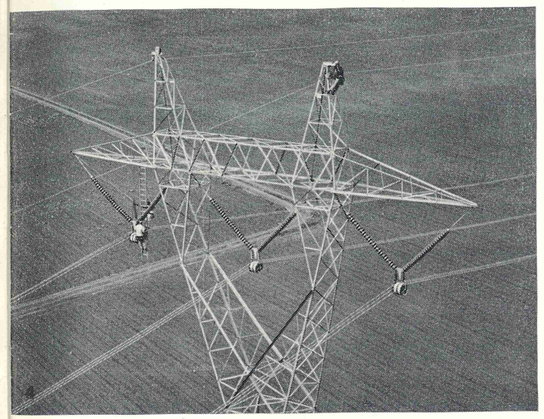
Clevis type with V-strings on all tangent phases. Tangent supports use 24 units per leg of 25,000-pound rating. Deadends use three yoked ball-socket strings per phase, 24 units each of 36,000-pound rating.

Towers:

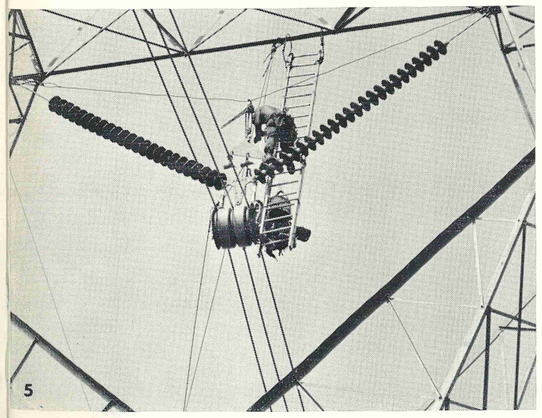
Height to ground wire, 124 feet, 6 inches. Height to bottom of crossarm, 105 feet. Length of crossarm 89 feet. Phase spacing 30 feet, 3 inches. Shielding angle of overhead ground wires, 19 degrees. Footing resistance, 10-12 ohms, brought to this value by counterpoise in location where necessary.

In some respects the Arkansas Power & Light Company section is almost a line-builder's ideal. The terrain is flat. Highways and rural roads provide frequent and easy access. The line may run for miles without necessitating removal of a tree. But this flat country has its drawbacks. When the rains come, they simply stay where they hit. There is no drainage. As one of the foremen put it, "The kind of mud we get is too thin to run a bulldozer and too thick to row a boat." And two or three feet of it is not uncommon. Men responsible for the time schedule on the line dread the arrival of the fall rains.

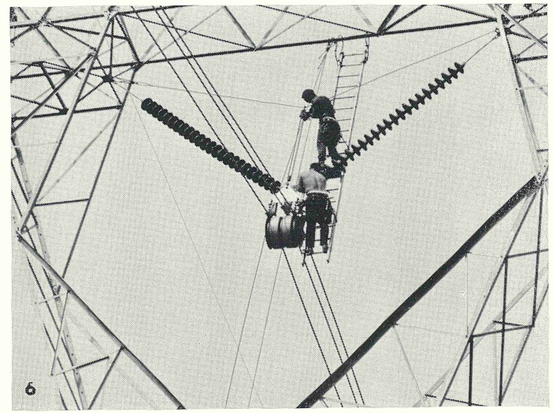
It was one of these fall rains, and its accompanying bottomless mud, that accounts for our publication of the A. P. & L. story in two parts. First the background of the line that was told in April, minus construction pictures . . . Now the pictures.



4



5



6

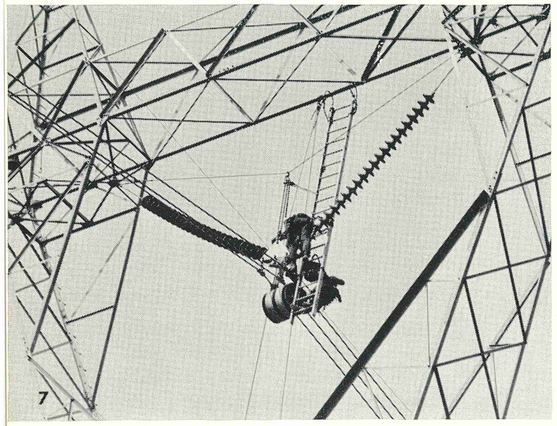
4. From a low-flying helicopter tangent construction can be studied in considerable detail.

5. First step in completion of a tangent support point. Note that the lifting rig consists of a triangular plate to which are attached three conductor clamps with keeperpieces removed. These act as supporting saddles to raise the conductors.

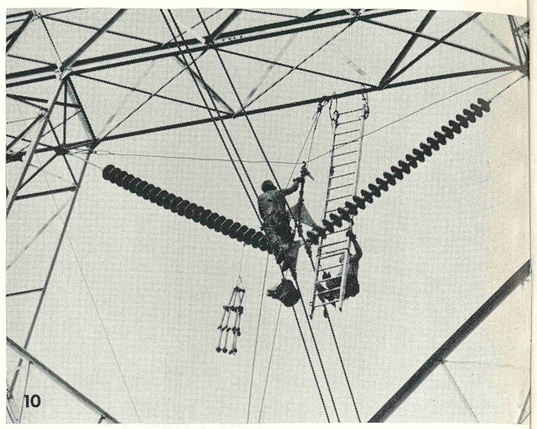
6. Center conductor is first lifted a short distance to its final position on the lower arm of the suspension yoke, and attachment is completed. Weight of the other two conductors is still supported on the sheave. In this way, total weight of the three conductors is not imposed on hoisting equipment. This is desirable, as it will be seen that the hoist is anchored to a span of cable. Available tower members directly above construction are not intended to take this vertical weight.

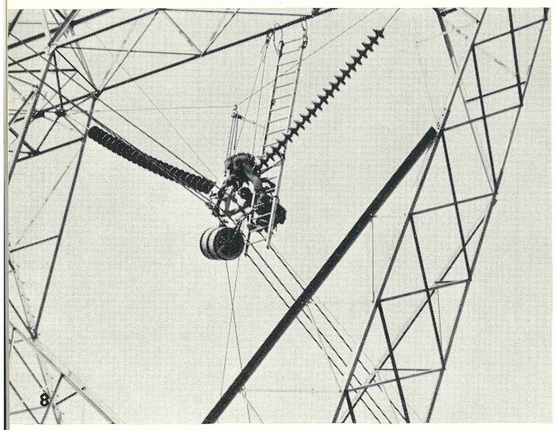
(Continued on next page)

(Continued from preceding page)


7

7. Outside conductors are then lifted into position. Note that the center hoisting saddle is free from the lower conductor which is now permanently attached.

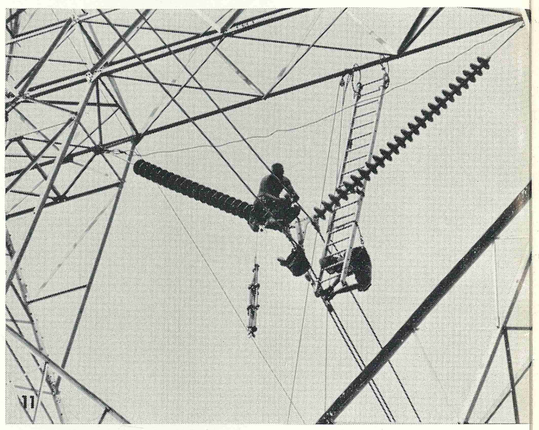

10


8

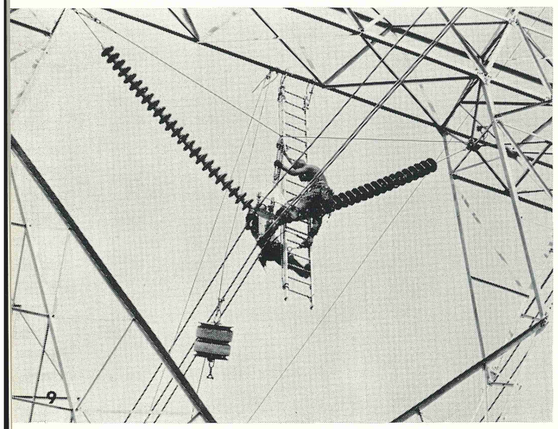
8. With conductors clear of the sheave, this equipment is lowered to the ground.

9. Outside conductors are transferred from the lifting rig to the permanent clamp attachment on the upper arms of the suspension yoke.

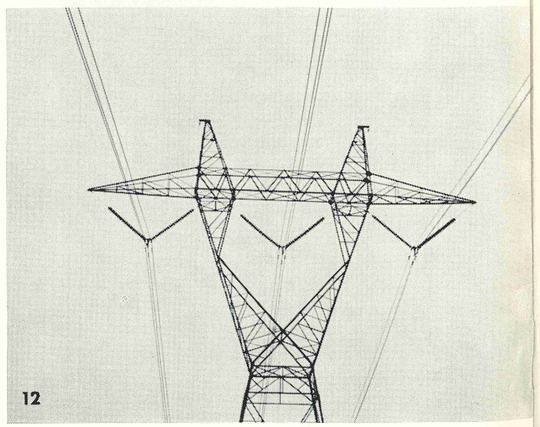
10. Lifting rig is swung free and suspension clamps are given a final check for bolt tightness. At this point of construction, a set of midspan spacers has been sent up and tied to a convenient point on one of the insulator strings. This keeps the spacers out of harm's way until needed, and still handy for the installation crew.


11

11. As a final step, vibration dampers are attached to the conductors.


9

12. Completed tangent tower. Height is 124 feet, 6 inches to the ground wire.


12

Holan's new pressure sensing system prevents overloading of derricks and aerial equipment

Unique overload device gives "Full Time" protection for men and equipment

For maximum protection of maintenance personnel and equipment, Holan has developed a new system of pressure sensing to prevent overloading of Holan derricks and aerial devices.

Conventional overload devices "stall out" the hydraulic systems of aerial devices or derricks when the demands of *initial* load exceed the rated capacity of the equipment. The problem is that load moments of aerial equipment may be inadvertently increased beyond rated capacity by maneuvering the upper arm to a more horizontal position. The same is true of derricks. In addition, loading on derricks may become excessive as the outer boom is extended, the earth borer embedded, or the winch overloaded.

Solution? Holan's "full-time" overload device. It continuously monitors the hydraulic pressure in the cylinder which determines capacity of the equipment -- main lift cylinders of derricks and Charger squirt booms, upper arm cylinder or cylinders of Bronco Elbows -- and actuates a hydraulic-mechanical overload device when the equipment reaches its rated capacity at *any time* during operation.

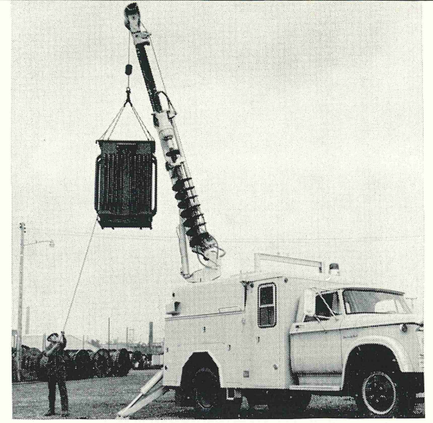
When this happens, all movement of the equipment stops. The operator then overrides the overload device and takes the necessary corrective action.

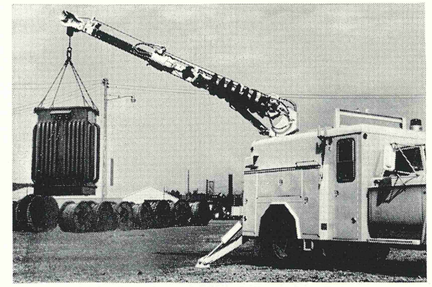
In the case of an overloaded Elbow, the operator returns the load to its original aerial position and lowers it by winch line or some other method. Depending upon the cause of derrick overload, the operator has several options such as increasing the angle of derrick arm elevation and lowering the load by winch line, retracting the extendible boom, or, if digging, reversing his earth borer motor to free an embedded auger.

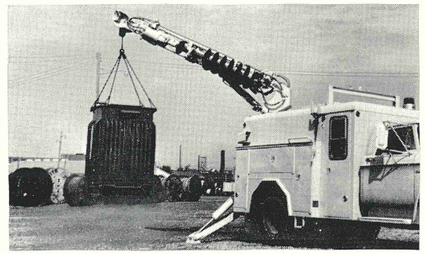
Most important, of course, is that Holan aerial devices and derricks equipped with the new device cannot be overloaded without the operator's knowledge. He must override and take corrective action -- or deliberately risk damaging the equipment.

On both derricks and aerial equipment, visual or audible load gages may be used in conjunction with the overload device. The device can also be used in the main lift cylinder of the lower arm on Bronco Elbows rated for derrick work.

For more information, write Holan -- Division of The Ohio Brass Company, 4100 West 150th Street, Cleveland, Ohio 44135.


NO PROBLEM: Capacity at this angle, 7,400 pounds.


PROBLEM: Capacity at this angle 3,500 pounds -- overload device actuated.


SOLUTION: Override the overload device, elevate boom, lower with winch line.

SOLUTION: Override the overload device, retract boom, lower.

"Solid" means solid when it comes to O-B line posts

Post insulators are exceedingly strong mechanically and have greater resistance to lightning when they are made of solid, wet-process porcelain. This is why O-B makes all its distribution posts up to 14 inches with solid porcelain bodies. Even larger posts would be solid were it practical to fire them without a heat distribution cavity. O-B solid porcelain bodies maximize line post advantages.

The best of porcelain technology is necessary to make solid porcelain. There can be no impurities or hollow spots. In this case "solid" means *solid*.

How does O-B do it? The best of raw materials are first tested to confirm quality and then combined into porcelain clay by a very precise process. White china clays and ball clays are mixed with water into a "slip'" suspension. This liquid clay is vibrated through a fine mesh screen to remove any impurities and then pumped into pressure tanks. Under pressure it is forced into filter presses which squeeze out much of the water, leaving a soft clay cake. These cakes are then fed into a "vacuum pug mill," where they are shredded, deaerated, and by screw extrusion converted into a round blank of clay which can be cut into working-size pieces called "pugs." In the case of post manufacturing, each "pug" is the right size for one distribution line post insulator.

If our mixing was complete, our refining thorough, and the drying just right, our "pug" has every chance of becoming a quality line post. Most O-B "pugs" do.

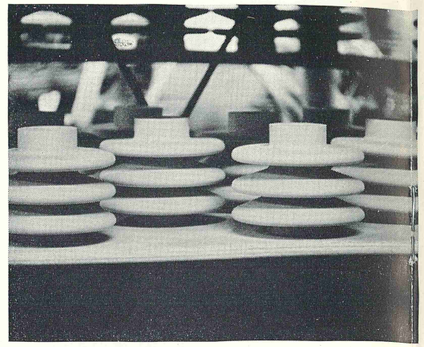
When it is dry and hard, the clay "pug" is shaped on a special lathe to form the solid porcelain body of a distribution line post. Its identity emerges. From here on it looks like a line post. It may be shaped to take an O-B clamptop fitting or the familiar groove of a tietop.

After it is shaped, each post is turned smooth on a finishing wheel, bathed in finishing glaze, regular or Skytone gray, according to order, and the appropriate end rims coated with an adherent sand glaze and sand to prepare these areas for mating between metal and porcelain later on.

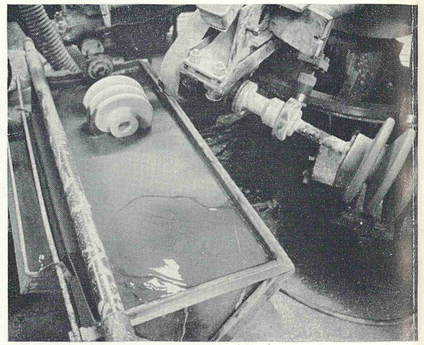
Trial by fire comes next as our solid clay insulator body goes to the kiln where it is vitrified into solid porcelain. Here is the payoff point for all our care so far. The posts are so arranged on kiln cars that they will have an even exposure of heat on their "long," "hot" trip through the tunnel kiln. Precisely controlled heat accomplishes vitrification in from two to three days. Our dull mass of clay is transformed into a hard-glazed, solid porcelain insulator body. It is now ready for assembly with its metal parts into a complete distribution line post.

For an insulator body to look right is not enough. It must test right. Ultrasonic waves probe beneath the glaze of each line post body to test for "solid," to find any faults or voids that may be concealed inside. Quality prevails in all but a very few, and "solid" means *SOLID* in making O-B distribution line posts.

"Solid" is just one feature of O-B line post insulators. Your Graybar salesman or O-B district manager is ready always to show you the rest.



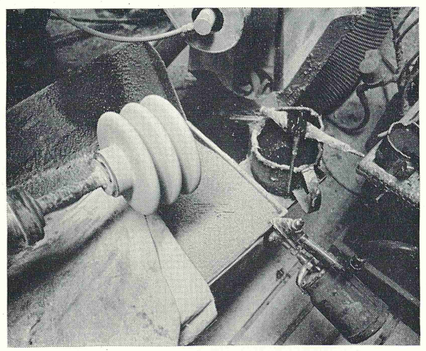
Clay bodies for distribution line posts ready for finishing wheel.



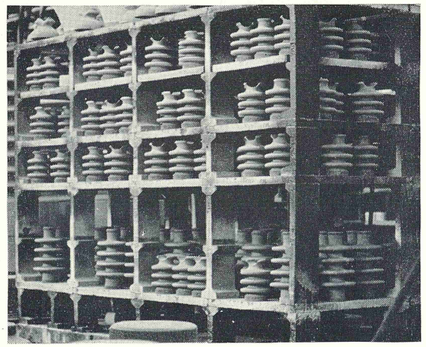
Clay body (left) turns in glazing bath. Notice glazed unit (right) drying on spindle after dipping. This operation on the finishing machine is automatic.

Completed posts are in evidence everywhere as Ohio Brass insulator manufacturing departments work to fill customer orders.

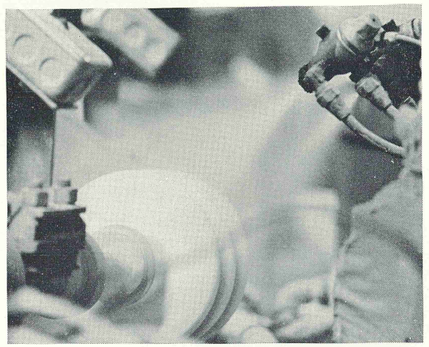
Operator of semiautomatic finishing wheel loads post shapes on machine, inspects them, and performs finishing, glazing, and sanding steps.



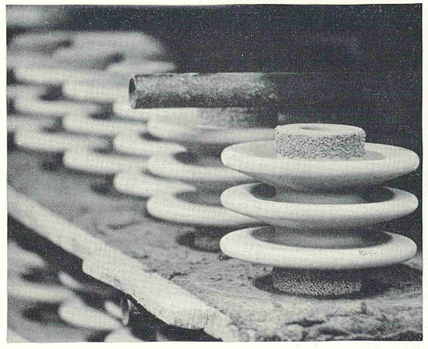
A two-step operation takes place at this station -- application of adherent sand glaze and sand to the rims. This prepares the unit for mating with metal clamptops and mounting bases according to type after the clay body is vitrified.



Kiln car loaded with tietop distribution line post bodies waits in line to begin vitrification firing in tunnel kiln.

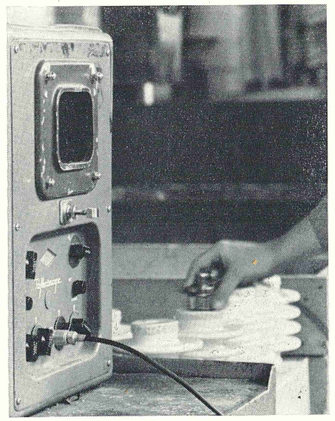


Clay units spin on individual stations as finishing wheel revolves and pauses at production steps such as this spraying operation.

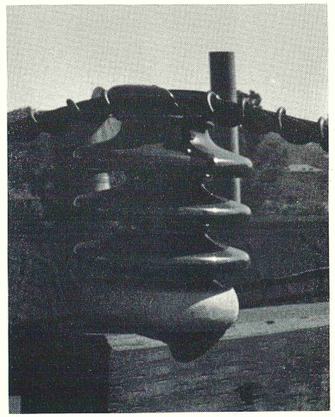


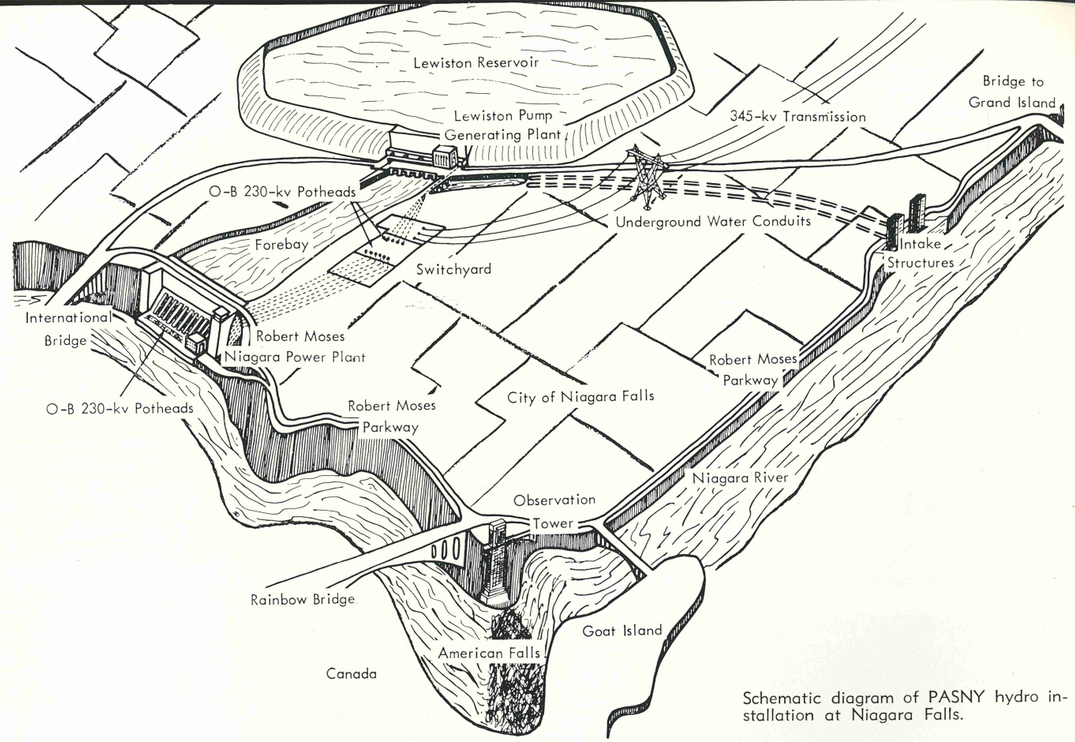
These clamptop distribution line post shapes are finished and ready for kiln firing.

Ultrasonic equipment testing O-B solid, four-petticoated line posts for defects in the porcelain.



Every O-B solid-porcelain line post is subjected to the ultrasonic test before delivery for distribution service.





Schematic diagram of PASNY hydro installation at Niagara Falls.

O-B Potheads funnel immense power into Niagara Switchyard

A more scenic location for a pothead installation will probably never be found than the Niagara Falls switchyard and power plants of the Power Authority of the State of New York (PASNY). If you included the Falls on your honeymoon or travels a few years ago, you probably would no longer recognize either the city or the area surrounding the Falls. In the short span of five years, PASNY engineering ingenuity, vast sums of money, and immeasurable personal determination have transformed the American side of Niagara Falls into a showplace of New York State and of the nation. Spectacular parks and parkways, dramatic lookouts and bridges, drastic urban renewal and railway relocation -- all combine to enhance the natural beauty of the river's edge. The American half of the Niagara power potential, developed as an integral part of the park system, produces on the average an astounding 13-billion kwhrs annually. Moreover, the famous Falls are just as awesome and breathtaking as ever.

Much has been published on the Niagara Falls power diversion project, but to recall briefly the relatively recent agreement, the Power Authority of the State of New York was licensed in 1958 to construct and operate a hydro plant at Niagara Falls, using capital supplied by private investors. Four-and-a-half years later the plant was operating at full power (2,190,000 kv). By treaty with Canada, Ontario Hydro on the opposite bank of the river receives an equal share of the available water from which it operates the Sir Adam Beck and other power plants.

Sixty Ohio Brass 230-kv capacitance-graded potheads are installed at the Power Authority's Niagara hydro project, making it O-B's largest pothead installation. More impressive, possibly, is the exceptional insight with which the potheads and underground transmission cables are integrated into the master plan by which the huge hydro plant and switchyard could be located in the midst of the scenic surroundings without detracting from their beauty.

Allocated water is taken from the Niagara River about two-and-one-half miles above the Falls and flows through underground conduits directly across the city of Niagara Falls to the forebay of the Robert Moses hydro plant, located about four miles below the Falls. From the forebay all or part of the water may be used immediately to generate power by passing it through the turbines of the Moses plant or it may be stored for future use by pumping it into the nearby Lewiston reservoir.

From the moment water is withdrawn from the Niagara River to the point it is returned downstream, the entire process is under the precise control of the PASNY electronic computer. The computer determines exactly the amount of water which can be withdrawn from the river and precisely calculates the proportions destined for immediate use and for storage. Because decisions are based on instantaneous data regarding load conditions, water availability, storage capability, pumping requirements and many other factors, the PASNY computer provides the operating procedure by which full utilization can be secured.

In practice the bulk of the water is withdrawn from the Niagara River after dark in accordance with the provisions of the treaty. Since most of this period is also the time of lightest load, much of the water flowing into the forebay is pumped into the Lewiston reservoir. When the plant load exceeds that which can be secured using water directly from the river, the motor-pumps of the Lewiston plant convert to turbine generators, and water from the reservoir is first used for generation as it flows back into the forebay, and again as it drops from the forebay through the Moses plant to the level of the Niagara River.

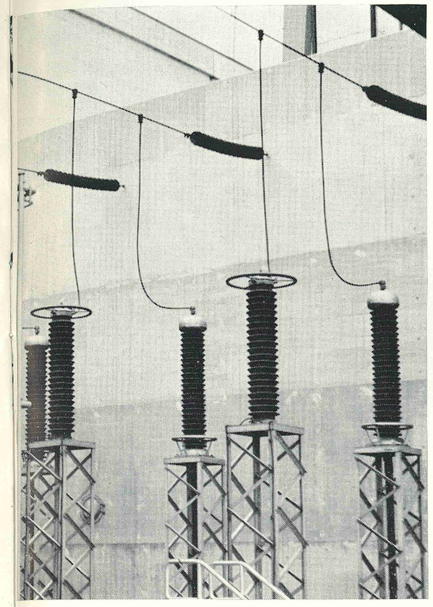
Power generated at 13.8 kv in the Robert Moses plant is raised to 115 and 230 kv by transformers located in outdoor bays above the turbine generator units. Transformer output is fed to the center of the Niagara switchyard through underground cables housed in a complex system of subterranean passages connecting the hydro plant with the switchyard.

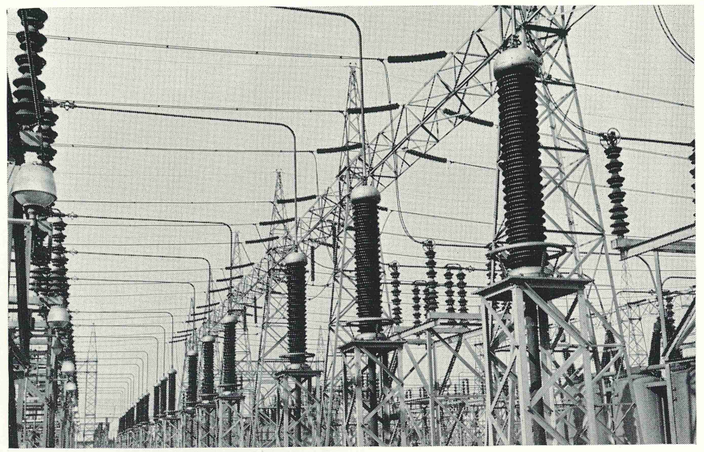
Each of the 18-high pressure, oil-pipe-type cables which comprise the six 230-kv, 200-mva supply circuits is terminated at both ends by O-B capacitance-graded potheads. Because of the difference of approximately 300 feet in the elevation of input and output potheads, housings of the potheads located in the transformer bays are of special construction to withstand the additional oil pressure.

Transformers at the Lewiston plant are connected to the switchyard in a similar manner. There are four 230-kv circuits, each having a capacity of 100 mva. O-B capacitance-graded potheads terminate each end of the 12 cables which form these circuits.

Lightning arrester protection is provided on each of the underground cables. Arresters are pedestal mounted in each of the transformer bays and are connected into the circuit between the pothead and transformer terminals.

Power Authority of the State of New York has achieved singular success in its objective of integrating a huge hydro system into the broad redevelopment plan for the Niagara Falls area. The superb arrangement of PASNY generating facilities serves as an extension of the grandeur of this world-famous scenic region. Ohio Brass is proud that its potheads contribute a measure of functional adaptability toward PASNY's basic objectives in the Niagara plant construction.





Underground cables from the transformers at the Robert Moses Niagara Power Plant provide six 230-kv circuits to the center of the Niagara Switchyard. All 18 cables are terminated at each end by O-B potheads.

Power from step-up transformers located in outdoor bays at both the Robert Moses and Lewiston plants is channelled to the Niagara switchyard through pipe-type, high-pressure oil cables. The 230-kv underground circuit shown is terminated by O-B capacitance-graded potheads. O-B Dynagap lightning arresters are connected between the pothead and bushing terminals.

Every year...for the life of a line...V-strings will pay you a cash dividend

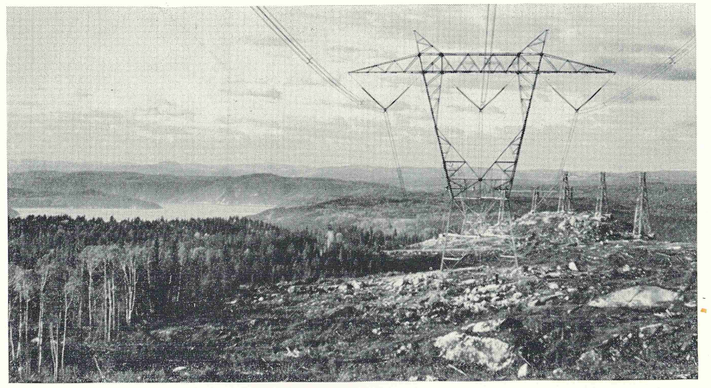
V-strings produce one of their major savings when the land is being opened for start of construction on a line. And, in this same category, 20 or 30 years later they will still be handing back money to their owners.

On a large 500-kv project now being built, V-strings permitted a reduction in right-of-way width of 50 feet. By not having to clear this 50 feet, the power company reports a specific saving of $750 per mile. Likewise, by not having to keep it clear and maintained ever after, this 50 foot strip, 390 miles long, is far from an insignificant item of economy.

While clearance may not always be a major consideration on certain lines, maintenance, weed, and brush control are practically a universal problem. In the case outlined above, approximately 2,400 acres were saved with V-strings. Multiply almost any maintenance cost per acre by 2,400 and you have an expense well worth avoiding, especially since it is repetitive.

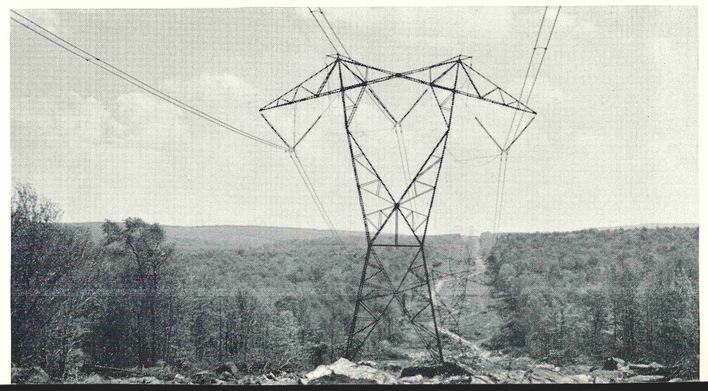
One can readily recognize the obvious economy of acreage that results from more narrow right-of-way made possible by V-strings. Eight feet of width equals one acre per mile, and, when you deal with hundreds of miles, a little off the side adds up to quite a sizable tract of land.

But the land is acquired only once. It is maintained perpetually. Over a period of time, the recurring expense of keeping a right-of-way in proper condition may be one of the most attractive economy possibilities in V-string construction.

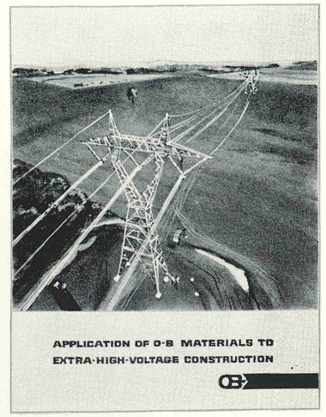


Here is a spectacular example of clearance. The right-of-way shown is 535 feet wide, to accommodate two 735-kv circuits. A third single circuit clearing approximately 25,000 acres of dense bush country. It is a fair assumption that lack of V-string construction would have added 20 per cent to right-of-way requirements, or another 5,000 acres of clearing. Saving 5,000 acres of original clearing, plus continuing maintenance, constitutes a cost factor of considerable importance.

The less of this kind of land that must be cleared, and continually maintained, the better . . . and the cheaper! On this line the owners claim a reduction in right-of-way width of 50 feet through the use of V-strings. Portions of the line penetrate somewhat remote mountainous country where available highways are infrequent. This has necessitated construction of lengthy and often extremely rugged access roads that can take as much as three hours away from a regular working day in transit to and from portions of the line. As these roads later deteriorate because of infrequent use, traveling time will probably increase and some sections may even become impassable for maintenance machinery, calling for the use of portable spray equipment or treatment from the air. In either case a saving of over six acres of right-of-way per mile can be a considerable item in repetitive maintenance cost.



New publication covers application of O-B materials to EHV construction



Offers opportunity for major buying economies through an understanding of items available in regular manufacture

For a long time, we . . . and many of our customers . . . have felt the need for a reference publication that would up-date general information on materials and services O-B is in position to supply for EHV construction. In the course of a decade of EHV development, these materials have grown from a few specialty items to a thoroughly rounded list of construction supplies.

While we are able, and quite willing, to design or develop new equipment, or to make amendments in existing models, it is highly advantageous to the buyer if he can specify materials in regular production where engineering and tooling costs are absorbed in quantity manufacture. One of the purposes of the new book is to show this line of EHV products, properly organized and classified. There is much to recommend the use of these materials wherever possible, and the first step in such a procedure is to display them.

Many companies embarking on an EHV program have asked what complications exist in the handling of materials in the course of construction. The essentials of building a support point, step-by-step, are shown for bundles of two, three, and four conductors.

Clamps and other hardware have been developed specifically for the EHV market. Their special characteristics are carefully explained.

Economic and technical aspects of V-string construction are explored in considerable detail.

Station designers have often commented on the apparent complexity of stacking post insulators for EHV service. They recognize the need for variety and flexibility, but sometimes find themselves confronted with confusing details. This is easily avoided if one understands the logical relationship of various interchangeable stacking units. With such an understanding one can readily visualize any desired stacking requirement. The chapter on this subject will be welcome to many station engineers.

Lightning arresters, bushings, and potheads for EHV service are described in their special relation to this class of application.

Laboratory facilities for early transmission research and continuing design investigation are thoroughly detailed.

In short, this new book helps answer the question, "What does O-B have to offer by way of materials and technical consultation for a proposed EHV project?"

Because of the rapid developments in EHV methods and equipment, many chapters of the new book became obsolete while later chapters were being written. This inserted many delays in preparation and accounted for the nearly two years that were devoted to its production. We feel that the market has currently stabilized at a point where a formal publication is practical, however, and hope it will perform a useful service to the many people concerned with EHV.

We have tried to send a copy to all customers we felt would be interested in this new book. Mailing to this group was made the end of October. But we know very well that such a selection cannot be complete, and we have probably inadvertently omitted many people. Therefore, if you do not receive this book during the first two weeks in November, and desire a copy, the attached coupon will facilitate your request.

Please send me a copy of your new book, APPLICATION OF O-B MATERIALS TO EHV CONSTRUCTION. (O-B Publication No. 1591-H)

Name

Title or function

Company

Address

City State Zip Code